

Ten Medicinal Plants from Burma

A literature study

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FEBRUARY, 2011

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Thesis in pharmacognosy

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February 2011

Abstract

In this Master thesis, there is an emphasis on scientific studies carried out to find information about the pharmacological effects and phytochemical constituents in 10 selected medicinal plants from Burma. These plants are taken from Burma collection compiled by Arnold Nordal during the period 1957-1961. Information was obtained about ethnomedicinal use, phytochemistry and biological activities of the 10 chosen plants.

After a thorough search in different databases, there were great differences in scientific studies for the 10 plants. Documentation for the traditional use varied for the different plants. In two of the plants (*Xylia dolabriformis* Benth. and *Pithecellobium lobatum* Benth.) there were not found documentation that can confirm the traditional uses. In three of the plants (*Antiaris toxicaria* Lesch., *Entada phaseoloides* Merr. and *Acacia pennata* Willd.) there was a fair number of documentation that would confirm some of the traditional uses. In the rest of the plants (*Ficus religiosa* L., *Mimosa pudica* L., *Pithecellobium dulce* Benth., *Albizia lebbek* Benth. and *Tinospora cordifolia* Miers.) there was found a reasonable number of documentations and scientific studies which would confirm most of the traditional uses of the plants. For *Albizia lebbek* Benth., it is antiasthmatic, antianaphylactic, antiinflammatory, nootropic, anticonvulsant, anxiolytic, antispermatogenic, antidiarrheal, antibacterial, anthelmintic and antiulcer activities that are documented in scientific studies. For *Ficus religiosa* L. antitumor, antioxidant, antidiabetic, antihelminthic, antimicrobial, antiamnesic, anticonvulsant, antiinflammatory and analgesic effect were documented. For *Mimosa pudica* L. it is antifertility, antidepressant, anticonvulsant, antibacterial, antivenom, antioxidant, antinociceptive and wound healing activity that is documented in scientific studies. *Tinospora cordifolia* Miers. has shown antioxidant, pro apoptotic activity, immunostimulatory, hypolipidaemic, anticancer, anti allergic, radio sensitizing, re-establishment of antioxidant defence and antiosteoporotic positive results. For *Pithecellobium Dulce* Benth. there was a fair number of documentations about antiinflammatory, antivenom, protease inhibition, antibacterial, antifungal, antidiabetic, hepatoprotective and abortion inducing activity.

In this thesis we have many interesting traditional indications that still have not been explained. Thus, it should be carried out several scientific studies so we may in the future be able to benefit by the properties of these medicine plants.

Preface

First I would like to greatly thank Professor Berit Smestad Paulsen for her availability, rapid feedback, correction of spelling errors, advice on literature search, and all kinds of scientific contribution to complete this work. I would also like to thank Librarian of Pharmaceutical Institute, Bente Katrine Rasch, for ordering several scientific articles to complete this work. I am grateful to my wife who has made it possible to carry out this task, and greatly thankful to my dear mother and sister who have always supported me and respected my decision to immigrate to Norway. At the end I would like to dedicate this thesis to my late father, Colonel Mohammadreza Sesoltani, who spent whole of his life to build up the future of his children. Thank you all.

Alireza Sesoltani
Oslo 27 February 2011

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Abridgement

α = Alfa

β = beta

γ = gamma

M= molar concentration

μ M= micro molar concentration

nM= nano molar concentration

i.p= intraperitoneally

i.v= intravenous

ED₅₀= effective dose which gives required effect in the 50 % of population under test.

IC₅₀= Concentration of a substance required to kill 50 % of test organisms.

LD₅₀= lethal dose which causes death in 50% test population.

μ g= microgram

mg= milligram

g= gram

Kg= kilogram

l = litre

ml= millilitre

min= minute

i.p. = intraperitoneal

i.v. = intravenous

i.m. = intramuscular

p.o. = peroral

m = meter

cm = centimetre

mm= millimetre

ppm = parts per million

in vivo = in the living organism. Often used in conjunction with medical studies conducted on animals or humans. Such studies are considerably more complex than *in vitro* studies, but provide the best scientific evidence for the effect of the tested substances.

in vitro = in test tubes. Often refer to medical research laboratory where it is not used living organisms, but where the trial takes place in cells in an environment outside the body.

etc. =et cetera

w/v = weight per volume

v/v = volume per volume

Introduction

In this thesis it will be focused on the scientific studies carried out on 10 selected medicinal plants from the Burma collection compiled by Arnold Nordal in the period of 1957-1961.

Selected medicinal plants of burma

- 1 *Ficus religiosa* L.
- 2 *Mimosa pudica* L.
- 3 *Tinospora cordifolia* MIERS.
- 4 *Antiaris toxicaria* LESCH.
- 5 *Entada phaseoloides* MERR.
- 6 *Acacia pennata* WILLD.
- 7 *Pithecellobium dulce* BENTH.
- 8 *Pithecellobium lobatum* BENTH.
- 9 *Albizia lebbeck* BENTH.
- 10 *Xylia dolabriformis* BENTH.

The purposes of this thesis

- Finding the traditional use of plants in Burma and other countries.
- Find scientific support to the traditional use of plants.
- Find interesting studies on the biological, pharmacological and toxicological activities of plants.
- Finding the chemical structures of the ingredients with documented biological activity.
- Discuss and decide on the biological and toxicological findings of the plants and see if the traditional uses of the plants have scientific support based on available data.

Structure of thesis

Latin name

Introduction

Synonym names

Finding in literature

Family description

Morphologic description

Traditional medicinal use

Phytochemistry and structures

Bioactivity

Clinical studies and therapeutic activities

Side effects and toxicity

Conclusion

References

Pictures references

Evaluation of the efficacy and safety

The practice of medical plant is widespread, so it is important to identify and evaluate the most common medicinal plants used in relation to efficacy and safety. It can be easy to think that a herbal remedy which used traditionally for many years, is proof enough that this is a safe treatment, but it is not.

Botanical Nomenclature

Being able to name things are said to be the first step toward knowledge and in research is important for communication with clear definitions of things. The Botanical Code ICBN is the internationally recognized rules and recommendations on plant nomenclature. The code will ensure that each taxonomic group (taxon) only has a common proper name.

According to ICBN, plant species shall have binomial names whose family name comes first, followed by species epithet (McNeill, 2006) [3]. The *Basionym* is the first valid published name of a taxon (Flat Rock, 2005) [4]. The correct name for research's seeking is the oldest published name. A correct name must also cite any probable previous authors

as part of the correct plant name to be valid (McNeill, 2006). Author citing is an important part of the name to show the connection to the source of the name.

What the synonym name is may be difficult to understand for a non-botanist.

Nomenclature in botany is constantly changing, and a plant can go under several Latin names. There are two ways a plant can get a scientific synonym name, the new arrangement of the plant to a new genus (a recombining), or it may be that a later discovery that was perceived as a distinct species should belong to an already named art (Flat Rock, 2005).

Literature and systematization

Plant searches in this study were based on binomial name and synonym name. Trivial names were not matching as it abounds with various trivial names according to language, dialect and place. The work has included a review of ethnomedicinal, phytochemical and pharmacological literature. Scientific journals are the main source of information in this study. It can be difficult to look for individual journals to search for information. The alternative is to go through the databases that search hundreds of journals simultaneously. The literature search was conducted using the databases SciFinder Scholar, Medline, PubMed, Science Direct, SwetsWise, International Plant Names Index (IPNI), BIBSYS Ask, X-port, Google Scholar and The Institute of Pharmacy's Library. SciFinder is the platform for multiple databases as Chemical Abstracts and MEDLINE. Within pharmacology was also Embase and ISI Web of Science checked.

Other sites that were used are The Plant List: a working list of all plant species (to find any synonyms), ECOCORP: Food and agriculture organization of the UN, Global Invasive Species Database, *Encyclopædia Britannica*, Germplasm Resources Information Network (GRIN) and Wikipedia: the free encyclopaedia. Some older botanic plants and flora checklists were available in scanned form on the Internet. Other databases such as Efloras (www.efloras.org) where several distinguished floras are available were used. The Royal Botanic Gardens, Kew uses also these as references. Literature from all these databases can be of varying quality.

Not all studies used in this paper were in English. Some of them were translated electronically by use of **Babylon** and **Google translator**. There were also several studies in other languages, but they are not included because of language problems.

Burma collection [1]

Department of Pharmacognocny has a unique collection of Burmese plants. Burma collection consisting of 441 plants, were collected by Professor Arnold Nordal in 1957-1961. Burma Pharmaceutical Industry (B.P.I) is a pharmaceutical factory in Burma which was built to meet the need for essential medicines to the people of Burma. In 1957, Nordal was commissioned as a UN adviser to help the BPI in their project that went beyond collecting raw materials from natural sources in Burma. His mission in Burma consisted of two parts, cultivating important medicinal plants that could be important for BPI and mapping the medical flora of Burma. Sources of collected information were from the representors of the indigenous medical system consisting of Buddhist monks, local medicine men, wandering medicine men, merchants in local markets, wandering traders and professional row material collectors.

Facts about Burma; officially the Union of Myanmar [2]

The international name of the country was Burma until 1989, and then the military junta SLORC (the State Council for the restoration of law and order) changed the name into Myanmar. The country is bordered to Thailand in the east and southeast, with Laos across the Mekong River in the east, to China (Yunnan and Tibet) in north-east, towards India in the northwest and a short border with Bangladesh in the west. The country's capital is Yangon (Rangoon). Official language is Burmese (belonging to the Sino-Tibetan language family) and religions are Buddhism, Christianity and Islam. The population is 53 414 400 (2010).

Climate [2]

Burma has a tropical monsoon climate with three marked seasons. From November to February is the cool and dry period, from March to May is the hot and dry period and from May to October is the rainy season. Rainfall quantities vary in different parts of the country. Coasts of Rakhine state and Taninthayi receive an average of about 5000 mm of rainfall each year. The mountains in the north receive usually over 2000 mm, and the lowland and Shan-Plateau about 1000-2000 mm. Mandalay-plain is considered as the "dry zone" receives only 500-800 mm of rainfall a year. Temperatures are high all year, except in the mountains. In July, the entire country's average temperature is over 27 degrees. The

warmest months of the monsoon (April-May) have a temperature over 30 degrees in many places.

Flora [2]

Large parts of the country, up to half of the land area covered by forest. Over 1000 meters you will find evergreen forest of oak and pine. In areas with rainfall 2000 mm a year or more, you find evergreen tropical trees. In areas with rain between 1000-2000 mm find monsoon forests with trees that fall the leaves in the warm season. In areas with rainfall less than 1000 mm vegetation consists partially of scrub forest. Native grasses and steppe land does not exist, but where the forest is cleared, it grows bamboo, ferns and stiff grasses. Mangroves grow dense in Ayeyarwady and Sittungdeltaets tidal belt.

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URL: <http://www.sn�.no/> (Read 23.02.11)
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1 *FICUS RELIGIOSA* L.



Introduction

Family	<i>Moracrae</i>
Butanical name	<i>Ficus religiosa</i> L.
Burmese name	Nyaung- bawdi
Parts of plant used	Leaves
Claimed medicinal Properties	In asthma (causes vomiting) [1]

It is said that *Ficus religiosa* is the tree Buddha was born under, and where he sat for six years of meditation. This plant is considered sacred by the followers of Buddhism, Jainism and Hinduism, and for this reason the name ‘Sacred Fig’ was given to it. *F. religiosa* is a large dry season-deciduous (or semi-evergreen) tree with a trunk diameter of up to 3 m. It is planted as a roadside tree and is commonly planted by Hindus in India near temples. The leaves and twigs are cut and given to cattle. The wood is used in sacrificial fires by Hindus and for packing cases. As an alternative solution for removing toxic metals from water/wastewater, leaves of the plant have a remarkable pollutant binding capacity for Ni (II) biosorption [3] [4] [35].

Synonym names

According to *THE PLANT LIST* the accepted name of the plant is *Ficus religiosa* L.

Synonym names are: *Ficus caudata* Stokes, *Ficus peepul* Griff., *Ficus religiosa* var. *cordata* Miq., *Ficus rhynchophylla* Steud., *Ficus superstitiosa* Link and *Urostigma religiosum* (L.) Gasp.

Urostigma affine Miq. is a name mentioned as unresolved [2].

Searching whole name *Ficus religiosa* L. in all records in IPNI (international plant names index) gives 4 results:

- ☐ Moraceae *Ficus religiosa* L. -- Sp. Pl. 2: 1059. 1753 [1 May 1753] (IK)
- ☐ Moraceae *Ficus religiosa* Forssk. -- Fl. Aegypt.-Arab. 180. 1775 [1 Oct 1775] (IK)
- ☐ Moraceae *Ficus religiosa* Decne. ex Miq. -- Ann. Mus. Bot. Lugduno-Batavi iii. 287. (IK)

□ Moraceae *Ficus religiosa* L. -- Species Plantarum 2 1753 (APNI)

Common Names: Bodhi Tree, Peepal Tree, Sacred Tree [36], Botree (Source: Websters Dict) English, Peepultree (Source: AH 505) English, Sacred fig (Source: Websters Dict) English, Pu ti shu (Source: F ChinaEng) Transcribed Chinese, Arbre de Dieu (Source: Mansf Ency) French, Figuier de pagodes (Source: Mansf Ency) French, Bobaum (Source: Zander ed17) German, Heiliger Feigenbaum (Source: Mansf Ency) German, Indischer Pepulbaum (Source: Zander ed17) German, Pepulbaum (Source: Mansf Ency) German, Pipal (Source: Websters Dict) India (Hindi), Pipul (Source: Mansf Ency) India (Hindi), Fico del diavolo (Source: Mansf Ency) Italian, Figueira-dos-pagodes (Source: D. Groth, p.c. 2005) Portuguese (Brazil), Figueira-religiosa (Source: D. Groth, p.c. 2005) Portuguese (Brazil) and Higuera de agua (Source: Mansf Ency) Spanish [37].

Results of searches in literature

Searching the name of **Ficus religiosa** in Google scholar resulted 5680 results, meanwhile the same search plus **medicinal** resulted 1960 results, 2 February 2011.

Searching the name in Pub Med found 35 results, in the ISI WEB OF KNOWLEDGS 90 results, while after refining results : (Subject Areas= *pharmacology & pharmacy or biotechnology & applied microbiology or chemistry, medicinal*) it resulted 16 results, 2 February 2011. In SciFinder 18 references were found containing "*Ficus religiosa* L." as entered (after removing duplicates: 15 results), and 5768 references were found containing the concept "*Ficus religiosa* L" (after removing duplicates: 5270 results, and after using *Categorize> biotechnology> medicine*: 637 results), 2 February 2011.

Searching the synonym names in Google scholar results are: *Ficus caudata* Stokes: 45, *Ficus peepul*: 282, *Ficus rhynchophylla*: 65, *Ficus superstitiosa*: 45 and *Urostigma religiosum*: 28 results (12 February 2011). It may show the popularity of the plant in researches.

Family of *Moraceae*

Moraceae, the mulberry family of the rose order (Rosales), has about 40 genera and some 1,000 species of deciduous or evergreen trees and shrubs. It is distributed often in tropical and subtropical regions. Species of the family contain a milky latex and have alternate or opposite leaves and small, petal-less male or female flowers. The fruits of most species are multiple because fruits from different flowers become joined [5].

Morphologic description

Ficus religiosa is a large evergreen tree up to 30 m. Bark of trunks and older branches are brown, smooth, branchlets and glabrous. Leaves are ovate, to 5 cm. Leaf blade are usually ovate to ovate-orbiculate, 7-25 x 4-16 cm, thinly leathery, base rounded to truncate, margins entire, sometimes wavy, apex abruptly long-caudate or long-acuminate, tip to 2.5-9 cm. Surfaces are glaucous, glabrous [12].

Traditional medicinal use

The roots, bark-skin, fruits, and leaves of *Ficus religiosa* are used as a great folk cure in many years. The bark is used as cooling and astringent and named to be useful in inflammations and glandular swellings of neck. Root barks are used for stomatitis, cleaning ulcers and as astringent in leucorrhoea and promoting granulations. According to Unani system of medicine, roots and barks are aphrodisiac and useful for lumbago. The roots are chewed to prevent gum disease. The fruit is said to be laxative, promotes digestion, aphrodisiac and checks vomiting. Ripe fruits used as alexipharmic (an antidote or defensive cure against poison, venom or infection), for foul taste, thirst and heart disease. The powdered fruit is taken to cure asthma. The seeds are named to be cooling, laxative and refrigerant. Seeds are used in urinary troubles. The leaves alone are climbed to be useful to treat constipation and leaves and young shoots together used as a strong laxative. Barks are used with some honey to treat gonorrhoea, ulcers, skin diseases and scabies. It has also been used to heal the wounds for years. The bark of *F. religiosa* is used to produce *Nalpamaram* (an important group of ayurvedic formulation) that widely used to treat skin diseases. Different parts of the plant are also used as antibacterial, antiprotozoal, antiviral, astringent, to treat diarrhoea, dysentery and ulcers [11] [38] [39].

Phytochemistry and chemical structures

Bleibtreu (1967) was one of the first researchers who studied the Phytochemistry of *F. religiosa*. The researcher reported that figs (fruits) of the tree contain the highest amount of serotonin (5-HT) compared with figs of other *Ficus* species [29] [24]. Methanolic extract of figs showed the presence of high amounts of serotonin (2.89%, w/w) of dried methanol extract of the fruit [10]. Later, Verma & Bhatia (1986) reported that major active constituents present in leaves include campesterol, stigmasterol, isofucosterol, α -amyrin, β -amyrin, lupeol, tannic acid, *n*-nonacosane, hexacosanol, *n*-octacosanol, and amino acids (such as l-cystine, l-lysine, l-arginine, dl-serine, dl-aspartic acid, glycine, dl-threonine, dl-alanine, l-proline, tryptophan, l-tyrosine, dl-methionine, dl-valine, and l-leucine) [32]. Ali & Qadry (1987) studied figs of the plant and found some amino acids such as asparagine, tyrosine, alanine, threonine and valine [28]. According to Husain (1992) the whole plant contains tannin, saponin gluanol acetate, β -sitosterol, leucopelargonidin-3 – O – α – L-rhamnopyranoside, lupeol, ceryl behenate, lupeol acetate, α - amyrin acetate, leucoanthocyanidin and leucoanthocyanin [9]. Zinc was reported to be found in high amounts by Duhan (1992) [27]. Further studies on the barks showed that they contain vitamin K1, *n*-octacosanol, methyl oleanolate, lanosterol, sitosterol, stigmasterol, bergapten, and bergaptol [30] [31]. The fruit also studied for presence of flavonols by Sultana (2008) and kaempeferol (160.8 mg/kg), quercetin (256.3 mg/kg) and myricetin (694.0 mg/kg) was reported [11]. According to Kunwar (2010) major chemical constituents of the whole plant are Phytosterolin, vitamin K and tannins [6]. The bark of *F. religiosa* is reported also containing tannin, saponin gluanol acetate, β -sitosterol, leucopelargonidin– 3 – O – β – D - glucopyranoside, leucopelargonidin – 3 – O – α – L-rhamnopyranoside, lupeol, ceryl behenate, lupeol acetate, α -amyrin acetate, leucoanthocyanidin, and leucoanthocyanin [9].

Bioactivity

Antitumor activity

Mousa (1994) studied the anticancer potency of *F. religiosa*. A specific strain of the Gram-negative bacterium, *A. tumefaciens*, induces Crown gall which is a neoplastic disease of plants. *A. tumefaciens* contains the Ti plasmid that carries the genetic information which codes for transforming normal wounded plant cells into autonomous tumour cells [40]. There is a strong dependence between the results of the potato disc assay and the 3PS (*in vivo*, mouse leukaemia) test [41]. As shown in *Table 1*, the fruit extract showed antitumor activity because they inhibited the tumours promoted by *A. tumefaciens*. The percentage inhibition was more than 20% in two separate experiments.

Table 1 [13]

The activity of fruit extracts of the four *Ficus* species in the brine shrimp and the potato disc bioassays

Test species	Brine shrimp bioassay (LC ₅₀)	Potato disc bioassay (% tumor inhibition)
<i>F. sycomorus</i>	> 1000	51
<i>F. benjamina</i>	> 1000	51
<i>F. bengalensis</i>	900	48
<i>F. religiosa</i>	400	45

LC₅₀ is the concentration that affected 50% of the larvae.

So according to Mousa (1994) fruit extracts of the plant presented antitumor activity in the potato disc bioassay, although it showed no remarkable inhibition on the uptake of calcium into rat pituitary cells GH₄C₁ [12] [13].

On the contrary, the methanolic and watery extract of *F. religiosa* were screened by Uddin (2009) for cytotoxic activity against healthy mouse fibroblasts and three human cancer-cell lines (gastric, colon and breast) using the MTT assay. According to results (*table 2*) the plant showed mild to no cytotoxicity against cell lines tested [20].

Table 2: Cytotoxic activity (IC₅₀) of *Ficus religiosa* extracts [20]

Healthy mouse fibroblasts: NIH3T3; three human cancer-cell lines: gastric: AGS; colon: HT-29; and breast: MDA-MB-435S

Species name	Part used	Extract	Yields (%)	Cytotoxic activity (IC ₅₀) ^a (mg mL ⁻¹)			
				NIH/3T3	AGS	HT29	MDA-MB-435S
<i>Ficus religiosa</i>	L	M	1.14	1.01	2.16	>2.50	>2.50
		W	1.33	>2.50	NC	>2.50	>2.50

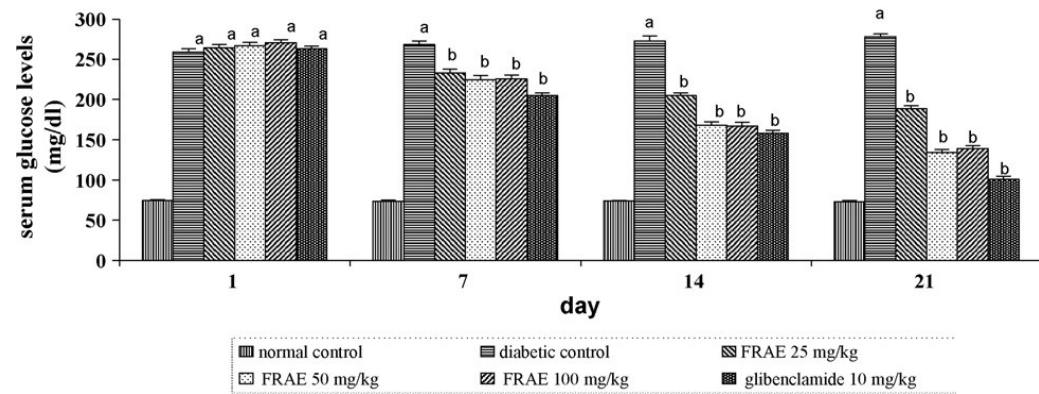
L: leaves; M: methanolic extract; W: watery extract; NC: no cytotoxicity at a concentration up to 2.5 mg/ml; IC₅₀ (50% inhibition of cell growth) calculated by probit analysis software, data was generated from two independent experiments, each experiment performed in triplicates.

Antioxidant and antidiabetic activity

Kirana studied the watery extract of *F. religiosa* bark at a dose of 100mg/kg and 200mg/kg. The extracts given orally to albino rats decreased the fasting blood glucose, increased the body weight of diabetic rats and decreased the activity of superoxide dismutase SOD in streptozotocin induced type II diabetic rats. The plant modulated the enzymes of antioxidant defence system to combat oxidative stress. According to Kirana, glutathione was also restored and inhibited forming malondialdehyde, and it provides its antidiabetic activity and antioxidant potential of the extracts [14].

Pandit (2010) also studied the antidiabetic effect of watery extract of the bark in normal, glucose-loaded hyperglycemic and streptozotocin-induced diabetic rats. Oral administration of extract caused significant decrease in blood glucose levels in all the models. According to Pandit the effects were dose dependent, and more significant in 50 mg/kg and 100 mg/kg than 25 mg/kg (*Figure 1*). The extract also showed noteworthy increase in serum insulin, body weight and glycogen content in liver and skeletal muscle of streptozotocin-induced diabetic rats. It also reduced the serum triglyceride level and total cholesterol. Antilipidperoxidative effect in the pancreas of streptozotocin-induced diabetic rats was also reported by the researcher [22]. Phytosterolin which is found in *F. religiosa* [6] also has hypoglycemic effects [17].

Figure 1: Effect of *F. religiosa* extract on blood glucose levels of streptozotocin-induced diabetic rats [22].



Each value is expressed as mean \pm S.E.M (n=6)

^a $P < 0.001$ when compared to corresponding values of the normal control

^b $P < 0.001$ when compared to corresponding values of the diabetic control

FRAE: *Ficus religiosa* watery extract

Antihelminthic activity

Iqbal (2001) was screened methanol extract of the bark for its *in vitro* anthelmintic activity. According to results *F. religiosa* was 100% effective by 4 hours post exposure. Most of the worms exposed to control (normal saline) remained alive till 4 hours post expose. After that, three out of six worms were found dead. Table 3 shows the results of this study [15].

Tablet 3: Effect of methanol extract of *F. religiosa* on the motility/survival of *Haemonchus contortus*

Botanical name of plant (Common name)	Time post exposure (hours)				Efficacy (at 6 hours post exposure)
	0	2	4	6	
<i>Ficus religiosa</i> (Pipal)	Alive=6 Dead=0	Alive=6 Dead=0	Alive=0 Dead=6	Alive=0 Dead=6	100%*
Normal saline (control)	Alive=6 Dead=0	Alive=6 Dead=0	Alive=4 Dead=2	Alive=3 Dead=3	50%

* indicates significant ($P < 0.05$) difference compared with control independently; NS = Non-significant

Antimicrobial activity

Ethanollic extracts of *F. religiosa* bark was studied by Aqil (2003) for its antimicrobial activity against seven bacteria (*Staphylococcus aureus*, *Salmonella typhimurium*, *S. paratyphi*, *S. typhi*, *E. coli*, *Shigella dysenteriae* and *Pseudomonas aeruginosa*), five filamentous fungi (*Aspergillus niger*, *Alternaria alternata*, *Fusarium chlamydosporum*,

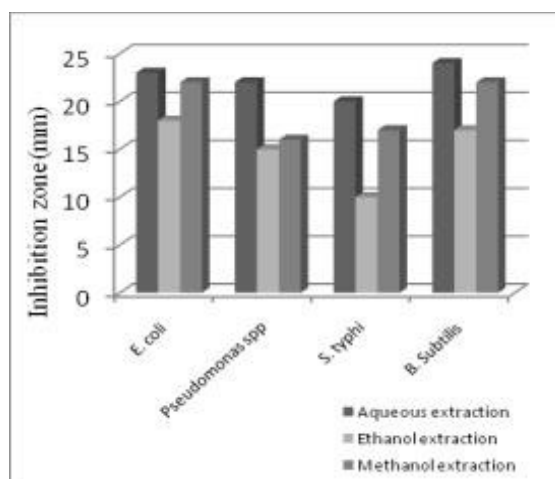
Rhizoctonia bataticola and *Trichoderma viride*) and a yeast (*Candida albicans*) with clinical origin. According to Aqil the crude leaves extracts of *F. religiosa* showed notable antibacterial activity and less antifungal activity [26].

Pawar (2010) studied extracts of five commonly available medicinal plants including *F. religiosa* bark for antibacterial activity on resistant and sensitive strains, isolated from skin and soft tissue infections. The aim his project was to develop a herbal ointment for controlling skin and soft tissue infections caused by multidrug resistant strains. Ten of the isolated *Pseudomonas*, nine of the *Staphylococcus*, four of the *Klebsiella* spp and *Enterobacter* spp and all the three *Escherichia coli* were resistant to major antibiotics.

Pawar reported that a combination of hot alcoholic extracts of *Ficus religiosa*, *Ficus infectoria* and *Piper betel* was most effective against all the isolates *in vitro*. The ointment showed bactericidal activity within 2 h against the resistant strain of *Pseudomonas* spp [21].

Preethi (2010) also studied the watery extract of some medicinal plants including *F. religiosa* to define antimicrobial activity of them. According to results of the study the watery extracts showed high antimicrobial activity (figure 2) against *B. subtilis* and *P. aeruginosa* [16].

Figure 2: Antimicrobial activity of *Ficus religiosa*



On the contrary, Dabur (2004) reported that methanolic extract of the plant did not inhibit *Aspergillus fumigatus* growth [18].

Antiamnesic effect

Amnesia refers to a difficulty in learning new information and/or recovering information from the past. It is described by severe disruption of memory without shortages in attention, intelligence, perception, or judgment. Anterograde and retrograde are two major classes of amnesia. Anterograde amnesia is weakness of memory for events occurring after the incident. Retrograde amnesia is weakness of memory of the events which have occurred before the incident [33] [34]. Kaur and others (2010) researched the effect of the methanol extract of *F. religiosa* figs on scopolamine-induced anterograde and retrograde amnesia in mice. As behavioural models for the assessment of memory, the researchers chose *Transfer latency* to the preferred niche in the elevated plus-maze and learning avoidance of passive behaviour to avoid punishment in the modified passive avoidance paradigm. Scopolamine was administered before training to induce anterograde amnesia and before retrieval for induction of retrograde amnesia in both models. Cyproheptadine (a non-selective 5-HT blocker) was given with the extract to investigate the association of serotonergic pathways in the antiamnesic effect of the extract. According to researchers the extract showed a significant dose-dependent improvement of memory. In addition, cyproheptadine pretreatment overturned the antiamnesic effect of the extract which confirms the association of serotonergic pathways for effect of the extract [23].

Methanolic and watery extract of *F. religiosa* (stem bark) researched by Vinutha (2007) for acetylcholine esterase inhibitory effect (*in vitro*). Results showed that methanolic extract of the plant had moderate acetylcholine esterase inhibitory effect and was more active than watery extract. It may suggest the traditional use of *F. religiosa* for improvement of cognition and memory longevity has some scientific basis [7]. Phytosterolin which is found in *F. religiosa* [6] also has CNS stimulant effects [17].

Antiasthmatic effect

Ahuja (2011) studied the antiasthmatic effect of *F. religiosa* on acute bronchospasm induced by histamine aerosol in guinea pig. According to results the methanolic extract of the fruit did not produce any spasmolytic effect. The researcher reported incomplete recovery effect of normal previous basal response by the extract, even after repeated and thorough wash out of it. This may indicate that methanolic extract of the fruits induced long-lasting contractile effect. Since serotonin produces contractile response in guinea pig airways, the high amount of serotonin in methanol extract may be responsible for the observed potentiating effect. Thus more specific studies are needed to decide about antiasthmatic efficacy of the plant [10].

Antiinflammatory and analgesic effect

The methanol extract of stem bark of the plant was studied by Sreelekshmi (2007) for its antiinflammatory effect in Wistar albino rat and analgesic effect in Swiss albino mice. According to the researcher, the extract inhibited significantly the carrageenan- induced rat paw oedema (Table 4). A significant inhibition of acetic acid-induced writhing in mice was also reported by researchers (Table 5). Further, a notable antilipid peroxidant effect from the methanol extract was also observed *in vitro* (Table 6) [8].

Table 4: Effect of *F. religiosa* stem bark methanol extract on carrageenan-induced paw oedema in rats

Treatment	Dose (mg/kg)	Paw volume after 3 h (ml)	Per cent inhibition
Carrageenan Control	0	0.73±0.04	0
Indomethacin	5	0.42±0.02*	52.94
FR	125	0.44±0.01*	55.41
FR	250	0.42±0.01*	52.99
FR	500	0.45±0.03*	56.29

Values are the mean ±S.D. n=5, *ANOVA $P \leq 0.05$ vs Carrageenan control

Table 5: Effect of *F. religiosa* stem bark methanol extract on acetic acid-induced writhing response in mice

Treatment	Dose (mg/kg)	Mean number of writhes in 20 min	Per cent inhibition
Acetic acid Control	-	32.0±0.20	-
Aspirin	25	7.2±0.70*	77.51
FR	125	25.3±0.55	21.94
FR	250	9.1±0.35*	71.56
FR	500	10.9±0.41*	65.93

Values are the mean ±S.D. n=10, *ANOVA $P \leq 0.05$ vs Acetic acid control

Tablet 6: Inhibitory effect of *F. religiosa* stem bark methanol extract on FeCl₂-ascorbic acid-induced lipid peroxidation in rat liver homogenate *in vitro*

Groups	Plant extract concentration (µg/ml)	MDA (n mole/mg protein)	MDA inhibition (%)
Normal Control	-	1.35 ± 0.60	-
FeCl ₂ -AA control	-	2.31± 0.02	-
FeCl ₂ -AA + FR	25	1.20 ± 0.02*	48.1
FeCl ₂ -AA + FR	50	1.38 ± 0.01*	40.3
FeCl ₂ -AA + FR	100	1.20 ± 0.02*	48.1
FeCl ₂ -AA + FR	200	1.40 ± 0.01*	39.4

Values are the mean ± S.D. n = 3, *ANOVA $P \leq 0.05$ vs FeCl₂-AA control

MDA= Malondialdehyde

Jung (2008) studied the effect of methanol extract of *F. religiosa* leaf on lipopolysaccharide-induced production of nitric oxide and proinflammatory cytokines. The results showed the extract presents antiinflammatory properties in lipopolysaccharide-induced activation of BV2 microglial cells. Immoderate production of inflammatory

mediators, nitric oxide and proinflammatory cytokines from activated microglia has been involved in neurodegeneration in human brain diseases [25].

Anticonvulsant activity

Sing (2009) researched the anticonvulsant activity of methanolic extract of *F. religiosa* figs in seizures induced by maximum electro-shock, picrotoxin and pentylenetetrazol. Cyproheptadine was used to study the reversal of protective effect of extract. The extract showed no neurotoxic effect. It potentiated pentobarbitone-induced sleep and inhibited seizures-induced by maximum electroshock and picrotoxin in a dose dependent manner. But it did not inhibit the picrotoxin and pentylenetetrazol-induced seizures. The anticonvulsant effect of extract was inhibited in the animals pretreated with cyproheptadine [24].

Clinical studies and therapeutic activities

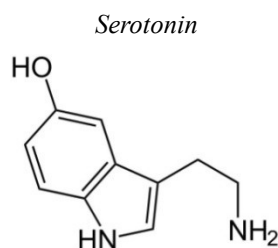
No clinical study is found about *Ficus religiosa* so far

Side effects and toxicity

Ficus religiosa is one of the oldest known human foods having a high safety profile [42]. Methanolic extract of the fruits up to dose 1000 mg/kg did not show any neurotoxic effects and mortality [24]. Pawar (2010) designed a test to measure the potential to cause sensitization of the ointments made of extracts of the plant. No erythema, edema and necrosis were observed [21]. On the other hand, Mousa (1994) had reported that *F. religiosa* showed activity in the brine shrimp test (*Artemia salina*) which suggests toxicity. According to Mousa's study, the plant contains toxic compounds [13].

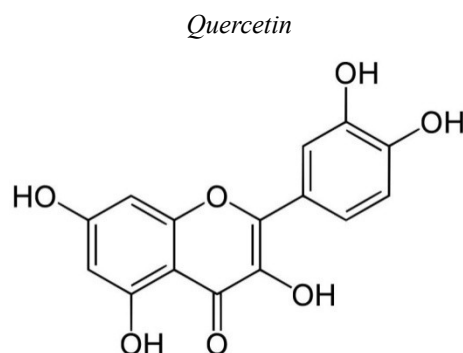
Conclusion

Ficus religiosa has been reported to be used in ethno medical treatment of asthma, skin diseases, as antibacterial, antiprotozoal, antiviral, astringent, to treat diarrhoea, dysentery, ulcers and in epilepsy. Serotonin and quercetin are two of the most bioactive compounds of the plant extracts. Serotonin is a neurotransmitter contributing to feelings of well-being. It has an important role in control of mood, appetite, sleep, as well as muscle contraction.



Serotonin also has some cognitive roles, including in memory and learning. It does not cross the blood–brain barrier, which means that ingesting serotonin in the diet has no effect on brain serotonin levels. Since serotonin is also a major gastrointestinal tract modulator, it may be produced by plants in fruits as a way of helping the passage of seeds through the

digestive tract. Quercetin Inhibits many enzymes including protein kinase C, lipogenases, lens aldose reductase, 3',5'-cyclic adenosine monophosphate phosphodiesterases.



It is named as a radical scavenger. Quercetin also inhibits smooth muscle contraction, and proliferation of rat lymphocytes. It has antigonadotropic, antiinflammatory, antibacterial, antiviral and antihepatotoxic effects [19] [43]. It may describe some of plant extract efficacies observed by the researchers. Recent researches have showed evidences of antitumor, antioxidant, antidiabetic, antihelminthic, antimicrobial, antiamnesic, anticonvulsant, Antiinflammatory and analgesic effects of *Ficus religiosa*. Although, the antiasthmatic effect of the plant was not proved so far.

Since the plant has a notable potent to be studied in clinical studies, further investigations should be conducted to isolate and characterize the active components of this *Ficus* species.

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Pictures references

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2 *MIMOSA PUDICA* L.



Introduction

Family	<i>Leguminosae</i>
Butanical name	<i>Mimosa pudica</i> L.
Burmese name	Tikayon
Parts of plant used	Whole plant
Claimed medicinal Properties	Diuretic, antiseptic etc. [1]

Mimosa pudica (*pudica* = shy) is a small and short-lived shrub, native to South America, but has become a pan-tropical weed. It is often grown for its curiosity value: When touched, it quickly folds its leaflets and pinnae and wilt downward at the petiole attachment. The leaves also wilt at night, and when exposed to rain or excessive heat. *M. pudica* is used as a medicinal plant in many regions [5] [6].

Synonym names

According to **The plant list** *Mimosa pudica* L. is the accepted name, and *Mimosa hispidula* Kunth is a synonym of *Mimosa pudica* L. [3].

Searching whole name *Mimosa pudica* in all records in **IPNI** (international plant names index) gives 4 results:

- Leguminosae *Mimosa pudica* L. -- Sp. Pl. 1: 518. 1753 [1 May 1753] (IK)
- Leguminosae *Mimosa pudica* Mill. -- Gard. Dict., ed. 8. n. 4. 1768 [16 Apr 1768] (IK)
- Mimosaceae *Mimosa pudica* L. -- Sp. Pl. 1: 518. 1753 [1 May 1753] (GCI)
- Mimosaceae *Mimosa pudica* L. -- Species Plantarum 2 1753 (APNI)

Other common names: Sensitive plant, humble plant, shame plant, sleeping grass (English), action plant (Australia), Almindelig mimose (Danish), Attaapatti (Telugu), betguen sosa (Guam), Chuimui (Hindi), co gadrogadro (Fiji), cogadrogadro (Fiji), dorme, dormidera, Gemeine Mimose (German), honteuse, humble plant (Australia), Khadiraka (Sanskrit), Kruidje-roer-me-niet (Dutch), Laajaalu (Sanskrit), laajak (Bengali), Laajari (Marathi), la'au fefe (American Samoa/Samoa), Lajaalu (Hindi), lajja (India), lajjalu (India), Lajjavanthi

(Hindi), lajjavathi (Bengali), Lajouni (Hindi), lazza bati (Bangladesh), limemeihr (Pohnpei Island), live and die (Australia), marie-honte, mateloi (Tonga), mayhont, mechiuaiu (Palau), memege (Niue), mimosa (Australia), morivivi, Muttidare muni (Kannada), Namaskaar (Sanskrit), ngandrongandro (Fiji), paope 'avare (Ngaputoru Island), pikika'a (Aitutaki Atoll), pikika'a (Palmerston (Avarau) Island), pohe ha'avare (Society Islands), pope ha'avare (Society Islands), pua hilahila (Hawaii), puteri malu (Brunei), rakau 'avare (Atiu Island), rakau 'avarevare (Ngaputoru Island), rakau pikika'a (Mangaia Island), rakau pikika'a (Rarotonga Island), Raktapaadi (Sanskrit), Reesamani (Gujarati), Samangaa (Sanskrit), sensitiva (Spanish), Sensitiva, sensitive (French), sensitive grass (English), sensitive plant (English), shamebush (Australia), shamelady (Australia), shameplant (English), shameweed (Australia), Shamipatra (Sanskrit), Sinnpflanze (German), , tho kandrodandro (Lau Island), tho ngandrongandro (Fiji), thothae jegri (India), ti mawi, tiare pikika'a (Cook Islands), tita 'avarevare (Ma'uke Island), tita 'avarevare (Miti'aro Island), tita pikika'a (Cook Islands), togop-togop (Sabah, Malaysia), Tottalavaadi (Tamil), touch-me-not, tuitui (American Samoa), tuitui (Samoa), Tuntokasvi (Finnish), vao fefe (American Samoa), vao fefe (Samoa), vao tuitui (American Samoa), vao tuitui (Samoa), vergonzosa (Australia) [4] [5].

Results of searches in literature

Searching the name of *Mimosa pudica L.* in Google scholar resulted 5760 results, meanwhile the same search plus **medicinal** resulted 1480 results, 10 February 2011.

Searching in Pub Med found 27 results, while in the ISI WEB OF KNOWLEDGS found 149 results, 26 January 2011.

Searching the whole name in SciFinder (after removing duplicates) resulted 81 results, and after refining with *Analysis, categorize: biotechnology: medicine:* found 24 results (29 January 2011).

It should be mentioned that a huge number of the crude results was about the movement mechanism of the plant, but it may also illustrate the popularity of this plant among other researches.

Family of *Leguminosae*

Legumes, the third largest flowering plant family, are an important ingredient of nearly all terrestrial biomes, on all continents (except *Antarctica*). The legume (or bean) family, which includes lentils, peas, beans, peanuts and soya, is important as a source of food because of its high protein content. These species range from dwarf herbs of arctic and alpine vegetation to massive trees of tropical forest. Many legumes are capable to fix atmospheric nitrogen in association with root bacteria or species of fungi. This tactics allows them to colonizing and growing in even the poorest soils, even as also helping to develop them. The main feature of the family is the fruit, a peapod which officially is known as a Legume. The Legume is adapted in many ways to make possible spreading by wind, animals and water. The family is divided into three subfamilies: *Papilionoideae*, *Caesalpinioideae* and *Mimosoideae*. Sometimes these subfamilies are documented as three separate families. The three subfamilies are usually recognizable by their flowers. The *Mimosoideae* are mostly tropical or subtropical trees and shrubs characterized by their small, regular actinomorphic flowers which are. The stamens are maybe the most beautiful part of the flower, the five not immediately obvious petals. The leaves have double pinnate leaflets [2].

Morphologic description

M. pudica is a small, prostrate or ascending creeping short-lived shrub. Some authors named it a wooden herb. It may reach 1 m in height when supported and more than 2 m in horizontal extension. The stem is erect in young plants, but becomes creeping or trailing with age. The reddish-brown, wooden stems are armed with bent prickles. The root system is made up of a taproot and extensive fibrous roots with nodules. The small branches are flexible and support leaves with 1 to 2 pairs of pinnae and 15 to 25 pairs of oblong leaflets 3 to 12 mm long. The flowers are pink and crowd together in globose heads. The legume (pod) is linear-oblong, 1 to 1.5 cm long and 3 mm wide, with short stiff hairs on the margins. The pods are born in groups and contain two to four brown seeds with hard seed-coats [6].

Traditional medicinal use

Mimosa pudica is used in Nicaragua and Mexico for stomach pain, as a sedative, to stop menstruation and for gonorrhea. In India the root is used as a temporary birth control and to help childbirth [8] [17]. The root is also used by snake charmers of north-east India to treat the snake bite patients [11]. The leaf juice and the whole plant extract are taken orally in to treat haemorrhoids. Leaves are crushed and placed over the navel of the child to stop urination during sleep. The root juice used topically to draw out the purulent stuff from boils and ulcers. Root decoction is taken orally to break apart kidney stones and send them out through urine [12]. The whole plant is also reported for curing dysentery [14]. Roots, bark and leaves are used In Bangladesh to cure frequent urination, burning sensations in the vaginal area, leucorrhoea, frequent urination, burning sensations in the vaginal area, leucorrhoea, bleeding of penis, diarrhea, hypertension. They are also used as an antidote to poison, haemorrhoids, skin wounds, toothache, stomachache and eczema. The whole plant is also used in other countries as well: to treat headache, alopecia (Panama), diarrhea, dysentery (Haiti), insomnia (Panama, Trinidad), as antidote to poison (Venezuela), sedative (Guatemala, Java) [16]. Some Chinese medicine preparations containing *M. pudica* are also tested and used treating schizophrenia [20], pervigilium [21], arresting bleeding, skin diseases [22] [26], hyperosteogeny [23], arthralgia, hyperosteogeny, assistant physical therapy [24], burn and scald [25] and AIDS [27].

Phytochemistry and chemical structures

Cellular and chloroplast acylglycerols, sterols, phospholipids and glycolipids of the leaves of *M. pudica* were studied and described by Choudhury (1980) (*Table 1*) [31].

Table 1: Total lipid composition of *M. pudica*

Constituent	% of total lipid	
	Leaves	Chloroplasts
Triacylglycerols (TG)	6.5	11.7
Diacylglycerols (DG)	5.2	4.7
Monoacylglycerols (MG)	4.0	4.5
Sterols	5.6	7.4
Sterol esters (SE)	3.4	1.8
Phospholipids	13.1	12.8
Glycolipids	13.7	21.1
Monogalactosyldiacylglycerols (MGDG)	2.4	6.8
Digalactosyldiacylglycerols (DGDG)	6.4	10.2
Sulfoquinovosyldiacylglycerols (SQDG)	2.7	2.0
Cerebroside	2.2	2.1
Total lipids (% tissue dry wt)	5.0	13.0

Misra (1971) had already isolated three *O*-glycosyl flavonoids named isoquercitrin, avicularin and apigenin-7-*O*-D-glucoside, and also four C-glycosyl flavonoids, cassiaoccidentalin B, orientin and isoorientin from the aerial part of the plant [32].

Studying the roots of the plant by Pande Pathak (published 2010) indicated presence of alkaloids, flavonoids, phytosterol, amino acids, tannins, glycoside and fatty acids. Further phytochemical studies with help of *Thin Layer Chromatography method* proved presence of flavonoids, phytosterol, alkaloids, amino acids in the petroleum ether fraction. Flavonoids were also found in the acetone fraction, as well as alkaloids in the chloroform fraction and the essential oils and fatty acids in benzene extract (*Tables 2 & 3*) [34].

Table 2 Thin layer chromatography scheme used to detect various extracts of roots of *Mimosa pudica*

Solvent system used	Detection Reagent	Observation	Inference	P	B	C	A	M	E
Ethyl acetate : Methanol: Water (75.5:13.5:10)	KOH	Red. (Vis) Yellow	Anthraquinone Anthrone	-	-	-	-	-	-
	Vanillin sulphuric acid	Red/ yellow/brown/blue-green	Bitter principle	-	-	-	-	-	-
	Dragendorffs reagent	Orange Red (vis)	Alkaloid	+	-	+	-	-	-
	NP/PEG and UV	Yellow/green/orange	Flavonoid	+	-	-	+	-	+
	VS reagent	Blue (vis)	Saponin	-	-	-	-	-	-
Toluene : ethyl acetate (93: 7)	VS reagent	Red/ yellow/brown/blue-green	Essential oil	+	+	-	-	-	-
	Hcl/Acetic acid	Blue brown	Valepotriate	-	-	-	-	-	-
	NH ₃ / KOH	Light Blue brown	Coumarin	-	-	-	-	-	-

P petroleum ether, B benzene, C chloroform, A acetone, M methanol, E ethanol

Table 3 Evaluation of roots of *Mimosa pudica*

S. No	Parameters	Values obtained w/w on dry weight basis
1	Ash value	17.36
2	Water soluble ash	9.65
3	Acid Insoluble ash	9.11
4	Alcohol soluble ash	4.55
5	Sulphated ash	3.78
6	Loss on drying	2.5
7	Moisture content	0.58-1.00
8	Foreign organic matter	0.5

Methanolic extract of the leaves were studied by Gandhiraja (2009). *Table 4* shows the phytochemical screening results of the plant [35]:

Table 4: Phytochemical screening of methanolic extract of *M. pudica*

S.No	Tests	Leaves of <i>Mimosa pudica</i>
1	Terpenoids	+
2	Flavonoids	+
3	Steroids	-
4	Anthroquinone	-
5	Glycosides	+
6	Sugars	-
7	Alkaloids	+
8	Quinines	+
9	Phenols	+
10	Tannins	+
11	Saponins	+
12	Coumarin	+

Another study provided by Rajendran (2009) a more complete list (*Table 5*) of compounds compare with those on *table 4*. Mimosine (an alkaloid), mucilage, tannins and turgorins were also reported to be found by the researchers [36].

Table 5: Phytochemical compounds of extracts of *M. pudica* leaves

Preliminary Phytochemical Test for Extracts of Mimosa pudica Linn. Leaves

S.No.	Test	n-Hexane	Chloroform	Ethylacetate	Methanol
1.	Alkaloids	-	+	+	+
2.	Glycosides	-	+	+	+
3.	Terpenoids	-	-	-	-
4.	Carbohydrates	+	+	+	+
5.	Proteins	-	-	-	-
6.	Steroids	+	+	-	+
7.	Flavonoids	-	+	+	+
8.	Phenols	-	-	-	+
9.	Tannins	-	-	-	-
10.	Quinones	-	-	-	-
11.	Saponins	+	+	-	-
12.	Resin	-	-	-	-
13.	Fixed oils & Fats	-	-	-	-
14.	Volatile oils	-	-	-	-

Note: + ve indicates positive result, whereas - ve indicates negative result.

Bioactivity

Antifertility activity

Ganguly (2007) studied root extract effects of *M. pudica* on vaginal oestrous and serum hormones to screen antifertility activity of the plant in albino mice. In some places in India *M. pudica* is a folk medicinal plant used as antifertility agent. The researcher gave dried methanol extract of the root to Swiss albino mice for 21 consecutive days and observed the oestrous cycle, LH, FSH, prolactin, estradiol and progesterone in both control and the test groups by using standard methods. At a dose of 300 mg/kg body weight/day, the researcher observed extending the oestrous cycle, notable increase in the diestrous phase and reducing the number of litters in albino mice. In the posttreatment period the number of litters was increased. The results of screening LH, FSH, prolactin, estradiol and progesterone cycle showed that the root extract changed and disturbed estradiol secretion and gonadotropin release [29].

In another study by Lans (2007), powdered roots were given to adult cycling female albino rats at dosages of 100 and 150 mg/kg body weight for 5 consecutive days. The researcher observed significant drop in the number of normal ova because of inhibition of steroidogenesis, further to imbalance in oestrogen-progesterone levels [8].

Antidepressant activity

According to Molina (1999) rats received salty, clomipramine, desipramine or several dosages of watery extracts from *M. pudica*. Then they were tested by *the forced swimming test* and the test for *difference reinforcement of low rates of response*. Any possible anxiolytic effects resulting from the extract were compared with those caused by diazepam. Molina reported the extract of *M. pudica* (6.0 mg/kg and 8.0 mg/kg, I.P.) reduced immobility in the forced swimming test and increased the rate of reinforcers received in the differential reinforcement of low rates of response test, compared to clomipramine (1.25 mg/kg, I.P.) and desipramine (2.14 mg/kg, I.P.). The researchers suggest the plant has an antidepressant-like profile similar to two tricyclic antidepressants clomipramine and desipramine in rat [33].

Anticonvulsant activity

Ngo (2004) reported effect of the plant against convulsion. The decoction of leaves injected intraperitoneal to male Swiss mice, and then they were tested by *Strychnine (STR) test*, *Pentylenetetrazol (PTZ) test* and *N-methyl-D-aspartate (NMDA) test*. Results showed that the decoction protected mice against pentylenetetrazol and strychnine-induced seizures, but had no effect against picrotoxin-induced seizures. It also antagonized *N-methyl-D-aspartate* induced turning behaviour [7].

Antinociceptive and wound healing activity

Nociception is the neural processes of encoding and processing noxious stimuli. It is the afferent activity produced in the peripheral and central nervous system by stimuli that have the potential to damage tissue. This activity is initiated by nociceptors (pain receptors). Once stimulated, a nociceptor sends a signal along the spinal cord, to the brain. (Loeser & Treede, 2008) [30]. Karthikeyan (2010) evaluated the antinociceptive activity of the watery extract of *M. pudica* in animal models. According to results it notably protected mice against STR and PTZ -induced seizures. Turning behaviour induced by NMDA in mice was dose-dependently antagonized by the plant. Conversely, the decoction of *M. pudica* showed no effect on PIC-induced seizures. The PTZ test uses to identify anticonvulsant drugs effective against generalized clonic seizures w9–12x. The analgesic properties of *M. pudica* were established by these results [9].

Kokane (2009) studied the roots of *M. pudica* for wound healing activity by incorporating the methanolic and the total watery extract in simple ointment base B.P. Excision, incision and estimation of biochemical parameter was the three models of wound healing activity evaluating used in this study. Administration of ointment containing 2% (w/w) the methanolic and 2% (w/w) the total watery extract showed wound healing activity notably. Kokane analysed the content of total phenols and reported 11% (w/w) in methanolic and 17% (w/w) in total watery extract. The researcher suggested that the good wound healing activity was possibly due to phenols components [22].

Antibacterial Activity

Three test organisms, namely, *Erwinia carotovora* pv *carotovora*, *Xanthomonas campestris* pv *campestris*, and *Pseudomonas solanacearum*, were used by Lirio (1998) for studying antibacterial activity of watery extract of the leaves. The plant extract was evaluated by use of the agar diffusion method. The extract showed significant inhibition effect of bacterial growth on *Xanthomonas campestris* pv *campestris* [10].

The microorganisms used by Rajendran (2009) [36] were 11 gram-positive and gram-negative bacterial organisms and 4 fungal organisms. According to the researcher all the extracts and methanolic fractions showed inhibitory response against all the organisms examined (*Table 6*). The chloroform and methanolic fraction *VII* (Methanol: Ethylacetate = 75:25) was the most effective one at the lower concentration of 33.33 mg/ml, and the antibacterial activity produced by it was greater than that of ciprofloxacin against the organisms. (*Table 7*) [36].

Table 6:

MIC of Extracts & Fractions of Mimosa pudica Linn. Leaves

S. No.	Extract s & Fractions	Concentration of the Extracts in µg/ml	Name of the Organism										
			1	2	3	4	5	6	7	8	9	10	11
1.	n-Hexane	33.3	+	+	+	+	+	+	-	+	-	+	+
		66.6	+	+	-	+	+	-	-	+	-	+	+
		133.3	-	-	-	-	-	-	-	-	-	-	-
		200.0	-	-	-	-	-	-	-	-	-	-	-
2.	Chloroform	33.3	+	+	+	-	+	+	-	-	-	+	+
		66.6	+	+	+	-	+	+	-	+	-	-	+
		133.3	-	-	-	-	-	-	-	-	-	-	-
		200.0	-	-	-	-	-	-	-	-	-	-	-
3.	Ethylacetate	33.3	+	+	+	-	+	-	+	+	-	+	+
		66.6	-	-	-	-	-	-	-	-	-	+	+
		133.3	-	-	-	-	-	-	-	-	-	-	-
		200.0	-	-	-	-	-	-	-	-	-	-	-
4.	Methanol	33.3	+	+	+	+	+	-	+	+	-	-	+
		66.6	+	+	+	+	+	+	+	+	-	+	+
		133.3	-	-	-	-	-	-	-	-	-	-	-

MIC= Minimum inhibitory concentration

Table 7:

Microbial Inhibition of Zone (mm) of Methanolic Fraction VII from *Mimosa pudica* Linn. Leaves

Micro Organisms	Category	Fraction VII	Ciprofloxacin
<i>Staphylococcus aureus</i>	Gram (+)	28	31
<i>Coagulase Negative Staphylococci</i>	Gram (-)	39	40
<i>Escherichia coli</i>	Gram (-)	29	29
<i>Klebsiella pneumoniae</i>	Gram (-)	30	29
<i>Pseudomonas aeruginosa</i>	Gram (-)	29	28
<i>Salmonella typhi</i>	Gram (-)	30	29
<i>Salmonella typhi typhi A.</i>	Gram (-)	30	29
<i>Salmonella typhi B</i>	Gram (-)	29	28
<i>Vibrio</i>	Gram (-)	28	27
<i>Enterococci</i>	Gram (-)	29	29
<i>Candida albicans</i>	Gram (-)	30	29

Values are an average of triplicate

Other studies showed also potential cytotoxic activities from the petroleum ether and methanol crude extracts of the root [19] [28].

Antivenom activity

Mahanta (2001) tested watery and alcoholic extracts of dried roots of *M. pudica* for their inhibitory activity on lethality, myotoxicity and toxic enzymes of *Naja kaouthia* (cobra) venom. The researcher reported that the watery extract, mainly the normal water extract, notably showed inhibitory effect on the lethality, myotoxicity and tested enzyme activities of venom [11].

Antioxidant activity

Chowdhury (2009) [13] and Haripyaree (2010) [19] screened the methanol crude extract of the aerial part of the plant (*in vitro*) for antioxidant activity. According to these researchers the methanol crude extract of the aerial part showed moderate antioxidant activity compared with ascorbic acid.

Table 8: Evaluation of antioxidant activity of methanolic extract of the aerial part of *M. pudica* [13]

Concentration ($\mu\text{g/ml}$)	% inhibition by Methanol extract (aerial part) (mean \pm SD)	% inhibition by Ascorbic acid
1	11.22 \pm 0.0055	44.91 \pm 0.92
5	15.89 \pm 0.011	47.95 \pm 0.98
10	20.128 \pm 0.008	53.86 \pm 1.78
50	31.731 \pm 0.0085	56.295 \pm 1.32
100	57.243 \pm 0.0055	63.49 \pm 1.51
500	65.064 \pm 0.0055	68.03 \pm 0.81
IC ₅₀ ($\mu\text{g/ml}$)	296.92	131.29

Clinical studies and therapeutic activities

No clinical study about *M. pudica* has been found so far.

Side effects and toxicity

In some studies the brine shrimp lethality bioassay [37] technique was used for to determine cytotoxic property of petroleum ether, chloroform and methanol extractives of both the aerial part and root of the plant. Spectrum did not show any toxic effects on experimental animals. Thus the plant considered as a non-toxic plant due to these results [13] [15]. No other scientific study is been found on side effects or toxicity of *M. pudica* so far.

Table 9: LC₅₀ data of the test samples of *M. pudica* in brine shrimp lethality bioassay [13]

Plant parts	Crude extracts	LC ₅₀ ($\mu\text{g/ml}$)
Aerial part	Petroleum ether	23.44
	Chloroform	20.89
	Methanol	80.0
Root	Petroleum ether	0.05
	Chloroform	78.87
	Methanol	0.035
Standard	Vincristine sulphate	0.35

Conclusion

Mimosa pudica is widely used as a cure to many illnesses: as sedative, to stop menstruation, as antidote to poison, as an antihyperglycemic, antidiarrhoeal, anticonvulsant and cytotoxic in folk medicine for decades. Presence of alkaloids, flavonoids, phytosterol, amino acids, tannins, glycoside and fatty acids in most parts of the plant is proved by many experiments. Antifertility, antioxidant, antivenom, antibacterial, wound healing and antidepressant activity *M. pudica* are studied *in vitro* and on animal models as well. The most of traditional uses of the plant seems to be reasonable. The plant has potential antibacterial components that may be of use for development of therapy of infections. Since a huge number of scientific studies have been provided to define and study unique movement of the plant and mechanisms of it, it is needed some *in vivo* and clinical studies to scientifically decide the value and potent of the plant as an alternative treatment to some illnesses.

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Pictures references

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3 *TINOSPORA CORDIFOLIA* MIERS.



Introduction

Family	<i>Minispermaceae</i>
Butanical name	<i>Tinospora cordifolia</i> Miers
Burmese name	Sindon-ma-nwe
Parts of plant used	Leaves, stem
Claimed medicinal Properties	Stomachic, cholagogue [34]

According to Arnold Nodal, the famous researcher from The University of Oslo, *Tinospora cordifolia* Miers. is widely used as stomachic and cholagogue in Burma [34]. *Tinospora cordifolia* is a large, glabrous, deciduous climbing shrub belonging to the family *Menispermaceae*. It is distributed throughout tropical Indian subcontinent and China, ascending to an altitude of 300 m. In Hindi, the plant is commonly known as *Giloya*, which is a Hindu mythological term that refers to the heavenly elixir that have saved celestial beings from old age and kept them eternally young. According to the 1918 United States Dispensatory, the plant has a long history of use in India as a medicine. The plants are long-lived and often locally abundant. It does not require any particular type of soil. It can grow in any temperature, although grows primarily in tropical areas. Myanmar and India are its native countries. There is a huge market for the roots, extract of *Tinospora* in medicinal use [1] (Wikipedia, 2010).

Synonym names

Searching in IPNI (international plant names index) gives 2 results:

- Menispermaceae *Tinospora cordifolia* Miers -- Ann. Mag. Nat. Hist. ser. 2, 7(37): 38. 1851 [Jan 1851] (IK)
- Menispermaceae [*Tinospora cordifolia* \(Willd.\) Hook.f. & Thomson](#) -- Fl. Indica, 1: 184 (1855):. (IK)

In other languages: [2] [3] [4]

Languages/Regions/Countries	Names
Arabic	Gilo
Bengal	Gadanch, Giloe, Gulancha, Gunchi, Nimgilo
Myanmar	Singomone, Sinzamanne
Kanarese	Amrytaballi, Madhuparne, Uganiballi
Chinese	K'uan Chu Hsing
Hindi	Giloe, Gulancha, Gulbel, Gulvel, Guduchi
Sri Lanka	Chintil
Malyalam	Amrytu, Peyamrytam, Sittamrytu
Persian	Gulbel
Nepal	Garjo
Sanskrit	Amrita, Chakrangi, Chandrahasa, Dhira, Guduchi, Guluchi, Jivanthika, Nagakumarika, Somalatika, Vishalya
Tamil	Amridavalli, Amudam, Asasi, Kunali, Narsindil, Paganrai, Pattigai, Silam, Sindil, Vayamadu
Telugu	Guduchi, Iruluchi, Madhuka, Manapala, Somida, Tellatippatige, Tippatige
Uriya	Gulancha, Gulochi

Bengali	Gulancha
Chenese	心叶青牛胆 Xin ye qing niu dan, 心葉青牛膽 (Taiwan).
English	Gulancha tinospora, Heart-leaved tinospora, Indian tinospora, Moonseed.
French	Guduchi, Tinofolin.
German	Guduchi-Kräutertee.
Gujarati	Galo
Kannada	Amrita balli
Malayalam	Amritu
Marathi	Gulavel
Nepalese	गुर्जो Gurjo
Oriya	Gulancha, Gulochi
Russian	Тиноспора сердцелистная
Sanskrit	Giloy, Gudoochi , Guduchi
Tamil	Amirthavalli, Seenthil, Shindilakodi, Sindhil kodi
Telugu	Tippaatigo, Tippatigo
Thai	ชิงช้าชาลี Ching cha chali
Indonesia	Brotowali, Andawali, Putrawali
Philippines	Makabuhay (Tagalog), Paliaban (Bisaya), Pañgiauban (Bisaya), Taganagtagua
Thailand	Boraphet (บอระเพ็ด)
South Asia	Guduchi , amrita (Sanskrit), giloe , gulancha (Bengali), giloya (Hindi), gado , galo (Gujarati), Gulvel (Marathi), duyutige , teppatige (Telugu), amrutha balli (Kannada), Shindila kodi (Tamil)

[2] [3] [4]

Finding in literature

Searching the name of *Tinospora cordifolia* in Google scholar resulted 2420 results, and the same search plus *medicinal* resulted 1840 results, April 2010. Search for "Any word= (*Tinospora cordifolia*) And Any word= (medicinal)" in "Articles" in X-port found 67 results, April 2010. It may illustrate the popularity of the plant in researches.

Family of *Menispermaceae*

Menispermaceae is the botanical name for a family of flowering plants. This family has been universally recognized by taxonomists. [Tubocurare](#), a neuromuscular blocker and active ingredient in [curare](#), is derived from plants of this family.

The [APG II system](#), of 2003 (unchanged from the [APG system](#), of 1998), also recognizes this family and places it in the order [Ranunculales](#), in the clade [eudicots](#).

It is a medium sized family of 70 [genera](#) totaling 420 extant [species](#), mostly of climbing plants. The great majority of the genera are [tropical](#), but with a few (notably *Menispermum* and *Cocculus*) reaching temperate climates in eastern [North America](#) and eastern [Asia](#) [5].

Morphologic description

T. cordifolia is a large, glabrous, deciduous climbing shrub. The stems are rather succulent with long filiform fleshy aerial roots from the branches. The bark is grey-brown and warty; the leaves are membranous and cordate; the flowers, small, yellow or greenish yellow, in axillary and terminal racemes or racemose panicles; the male flowers clustered and females usually solitary; the drupes are ovoid, glossy, succulent, red and pea-sized; the seeds curved. It grows throughout tropical area, ascending to an altitude of 300m [6].

Traditional medicinal use

The plant is used in Ayurvedic rasayanas to improve the immune system and the body's resistance against infections. The stem has been used in urinary diseases, dyspepsia, fevers and general debility. The bitter principles present in the drug show anti-inflammatory, antiperiodic, antispasmodic, and antipyretic properties. It is used as an immunomodulator in immunosuppression of obstructive jaundice, hepatic fibrosis, peritonitis and sepsis. The plant has also been found effective in preventing fibrous changes and promotes regeneration of the liver against CCl₄ induced hepato toxicity [7].

Similar species like *Tinospora crispa* and *Tinospora rumphii* Boerl are also used in herbal medicine as a hepatoprotectant, protecting the liver from damage that may occur following exposure to toxins. Recent research has demonstrated that a combination of *T. cordifolia* extract and turmeric extract is effective in preventing the hepatotoxicity which is otherwise produced as a side effect of conventional pharmaceutical treatments for tuberculosis using drugs such as isoniazid and rifampicin [8]. Furthermore *Tinospora cordifolia* has been used for centuries for treating various ailments including cancer in Ayurvedic system of medicine [9]. The natives and traditional healers of *Chhattisgarh* have rich traditional medicinal knowledge about the plant. It is used both internally and externally. They use it in treatment of over 50 common diseases with the help of about 200 herbal combinations. With root and stem, in *Chhattisgarh* leaves are also in use as medicine. Its presence in home gardens clearly indicates its popularity among the natives. For Leucoderma many traditional healers use this herb with *Psoralea corylifolia*. The healers also prepare an herbal solution using many common herbs including *T. cordifolia* which is used for special bath, recommended for patients suffering from skin diseases. It uses also as a treat for diabetic and heart patients. The plant in combination with other herbs is also considered best for the treatment of Bavasir (Piles), Pelia (Jaundice), and treatment of different types of fevers. Simple fever can be treated with juice only. The healers inform that the plant stem powder should not be stored over one year, otherwise its medicinal properties start decreasing and also due to storage many toxins develop in powder. Many natives use the fruits in face care. The traditional healers of Ambikapur region use it in treatment of boils. The leaf juice uses as eye tonic. The juice is also applied inside the eyes for the treatment of conjunctivitis and cataract (Motiabind). The root bark of *T. cordifolia* is also used in treatment of respiratory troubles particularly in asthma. The decoction of whole herb possesses anti-venom properties and climbed to be useful in case of snake [10].

Phytochemistry

Alkaloids

Active principle present	Part in which found
Berberine, Palmatine	Stem
Tembetarine, Magnoflorine	Stem
Choline, Tinosporin, Isocolumbin, Palmatine,	Root
Tetrahydropalmatine, Magnoflorine.	Root

Glycosides

Active principle present	Part in which found
18-norclerodane glucoside Furanoid diterpene glucoside Tinocordiside, Tinocordifolioside. Cordioside, Cordifolioside A, Cordifolioside B, Syringin, Syringin-apiosylglycoside, Palmatosides C, Palmatosides F, Cordifolioside A, Cordiofolioside B, Cordifolioside C, Cordifolioside D, Cordifolioside E.	Stem

Diterpenoid Lactones

Active principle present	Part in which found
Furanolactone, Clerodane derivatives [(5R,10R)-4R-8R-dihydroxy-2S-3R:15,16-diepoxy-cleroda-13 (16), 14-dieno-17,12S:18,1S-dilactone] and Tinosporon, Tinosporides, Jateorine , Columbin.	Whole plant

Steroids

Active principle present	Part in which found
β -sitosterol, δ -sitosterol, 20 β -hydroxy ecdysone.	Aerial part
Ecdysterone, Makisterone A, Giloinsterol.	Stem

Sesquiterpenoid

Active principle present	Part in which found
Tinocordifolin.	Stem

Aliphatic compound

Active principle present	Part in which found
Octacosanol, Heptacosanol, Nonacosan-15-one.	Whole plant

Miscellaneous compounds

Active principle present	Part in which found
3, (α , 4-di hydroxy-3-methoxy-benzyl)-4-(4-hydroxy-3-methoxy-benzyl)-tetrahydrofuran.	Whole plant
Jatrorrhizine .	Root
Tinosporidine, Cordifol, Cordifelone, N-trans-feruloyl tyramine as diacetate, Giloin, Giloinin, Tinosporic acid.	Whole plant

Polysaccharides

Active principle present	Part in which found
Arabinogalactan	Stem

Bioactivity

Antioxidant activity

Antioxidant activity of *Tinospora cordifolia* roots in experimental diabetes has studied by P. Stanely Mainzen Prince and Venugopal P. Menon. They made an attempt to study the antioxidant properties of *T. cordifolia* roots in alloxan diabetic rats. They observed that oral administration of an aqueous *T. cordifolia* root extract for 6 weeks resulted in a decrease in the levels of plasma thiobarbituric acid reactive substances, ceruloplasmin and α -tocopherol in alloxan diabetic rats. The root extract also caused an increase in the levels of glutathione and vitamin C in alloxan diabetes. Results show that the root extract at a dose of 5.0 g/kg had the highest effect, and were more effective than glibenclamide. Insulin restored all the parameters to near normal levels. These findings suggest that *Tinospora cordifolia* root extract has an antioxidant property in alloxan diabetes [12]. Others investigated the antiulcer and antioxidant activity of Pepticare, a herbomineral formulation of the Ayurveda medicine including: *Glycyrrhiza glabra*, *Emblica officinalis* and *Tinospora cordifolia*. They concluded that Pepticare has a significant antiulcer activity which its antioxidant activity can possibly be responsible for it [35].

Pro apoptotic activity

In another study the stem of *T. cordifolia* was extracted with different solvents using soxhlet apparatus and tested for proapoptotic activity of all the fractions. The researchers found that the hexane fraction showed potent proapoptotic activity [13] [14].

Immunological activity

Polyclonal mitogenic activity

In a study an arabinogalactan of mean M_r 2.2×10^6 has been isolated from the dried stems of *T. cordifolia*, and examined by methylation analysis, partial hydrolysis and carboxyl reduction. According to researchers purified polysaccharide showed polyclonal mitogenic activity against B-cells, and their proliferation did not require macrophages. This study shows that the aqueous extract of *T. cordifolia* contains polyclonal B-cell [15].

Inhibiting the growth of bacteria

T. cordifolia is a rich source of natural vitamin C that has been proved to be effective in inhibiting the growth of bacteria and in building up the immune resistance. In one research using human white blood cells, it increased the killing ability of macrophages, the immune cells responsible for fighting invaders [28]. This suggests an immune-boosting ability of the plant.

Proliferation of stem cells

Another study provides scientific support to the alleged immunostimulatory property of *T. cordifolia*, methanolic extract of which was also found to reduce the solid tumor volume in mice significantly. The extract showed to stimulate the proliferation of stem cells by increasing in total white blood cells and bone marrow cells. Furthermore, they observed that it increased the number of α -esterase-positive cells. *T. cordifolia* also stimulated the humoral immunity by increasing in antibody-producing cells and circulating antibody value. The extract could furthermore stimulate the phagocytic activity. According to researchers the extract was almost comparable to cyclophosphamide at the studied concentration. In addition it showed synergistic effects with cyclophosphamide in reducing animal tumors [16].

Hypolipidaemic effect

P. Stanely Mainzen Prince, Venugopal P. Menon- and G. Gunasekaran undertook a study to evaluate the hypolipidaemic effect of an aqueous extract of *T. cordifolia* roots. Administration of the extract of *T. cordifolia* roots for 6 weeks resulted in a significant reduction in serum and tissue cholesterol, phospholipids and free fatty acids in alloxan diabetic rats. The root extract

at a dose of 5.0 g/kg body weight showed highest hypolipidaemic effect. The results shows that a continuous administration of an aqueous extract of *T. cordifolia* root for 6 weeks prevents elevation of serum and tissue lipids secondary to the diabetes state. P. Stanely Mainzen Prince and others suggest that the hypolipidaemic effect of the plant can be explained as a direct reduction in the blood glucose concentration [17]. In another study the efficacy of *T. cordifolia* stem aqueous and alcoholic extracts in different dosages on blood lipid profile in streptozotocin induced diabetic albino rats was investigated. The drug was administered orally for rats of 4 different groups treated with *T. cordifolia*. Efficacy of *T. cordifolia* in ameliorating in lipid metabolism caused by diabetes was compared with the Lante Zinc Insulin treated diabetic rats. Plasma total cholesterol, triglycerides, free fatty acids, phospholipids and lipoproteins like high density lipoprotein, low density lipoprotein and very low density lipoprotein -cholesterol levels were measured according to the standard biochemical methods. Drug treated diabetic animals showed a significant ($p < 0.05$) effect of *T. cordifolia* on all these parameters compared to untreated animals. According to researchers treatment with insulin restored all these altered parameters to near normal levels in diabetic animals. Plasma total cholesterol, triglycerides, free fatty acids and phospholipids in untreated diabetic rats were raised to high levels during this study period. *T. cordifolia* treatment in diabetic rats showed a significant reduction in all these lipids profile levels compared to untreated diabetic animals. Furthermore, as the researchers report, the aqueous extract showed better potency in decreasing the raised lipids profile. Efficacy of *T. cordifolia* in ameliorating all these parameters was good compared to insulin. The LDL and VLDL cholesterol levels were increased and the HDL cholesterol levels were decreased significantly in untreated diabetic rats compared to control group. It is reported that after 10 and 30 days of treatment, significant effect of *T. cordifolia* on plasma HDL cholesterol levels was observed. In addition, it reduced the raised levels of LDL and VLDL cholesterol effectively in these treated diabetic rats. On the other hand, they have also observed that the levels were not normalized even after 30 days of *T. cordifolia* treatment. Treatment with insulin could normalize these altered lipids profile in insulin treated diabetic rats. In conclusion the researchers climbed *T. cordifolia* stem extract is able to ameliorate the derangements in lipid metabolism caused by diabetes mellitus in streptozotocin induced diabetic rats towards normal level [23] [26].

Anticancer activity

Mice transplanted with Ehrlich ascites carcinoma (EAC) receiving dichloromethane extract of *T. Cordifolia* (TCE), showed a dose dependent rise in tumor-free survival. The highest number of survivors was observed at 50 mg/kg TCE, which could be considered as an optimum dose for its neoplastic action. The average survival time and median survival time for this dose were approximately 56 and 55 day, compared with 19 day of non-drug treated controls. According to results, administration of 50 mg/kg TCE resulted in 100% long-term survivors (up to 90 days). TCE was administered after 1, 3, 6, 9, 12 or 15 days of tumor inoculation, and these days have been considered as stage I, II, III, IV or V. The greatest anticancer activity recorded by researchers, was for stage I, II and III. But treatment of mice at stage IV and V did not increase the number of long term survivors, despite an increase in average survival time and median survival time. The researchers observed that EAC mice receiving 50 mg/kg TCE showed a time dependent decrease in the glutathione activity. This reduction was accompanied by a significant increase in lipid peroxidation. The researchers conclude that TCE dominated cytotoxic effect on tumor cells by reducing the glutathione concentration and increase in lipid peroxidation at the same time [18] [19].

The researchers conclude that *T. cordifolia* was able to prevent malignancy and inhibits tumor growth in solid tumor model. Another investigation showed the preventive potential of Epoxy clerodane diterpene (ECD) from TCE in diethylnitrosamine (DEN) induced hepatocarcinogenesis. The results of investigation showed that decrease in serum transaminase enzymes maintained the functional integrity of membrane. And the researchers concluded that it happened because of protective effect of ECD. Some biochemical and histological studies also supported the chemopreventive properties of ECD. It has been concluded the results confirm that ECD plays a dual role by both blocking carcinogen metabolic activation and enhancing carcinogen detoxification [27] [29].

Protective effect on mast cell mediated allergic reactions

In another study the effect of an aqueous extract of *T. cordifolia* stem on mast cell mediated allergic reactions was investigated *in vivo* and *in vitro*, and its possible mechanism was studied. According to results, *T. cordifolia* (125 to 1000 mg/kg) dose-dependently inhibited compound 48/80 induced lethality in rats, histamine induced bronchial asthma in guinea pigs and histamine induced paw edema in mice. In addition, TC significantly inhibited the

secretion of tumor necrosis factor- α (TNF- α) in antidinitrophenyl (DNP) IgE-stimulated rat peritoneal mast cells. On the other hand, *T. cordifolia* in activated mast cells reduced intracellular calcium levels. The investigators concluded that *T. cordifolia* may be helpful in the treatment of allergic disorders. It may be also concluded that it has a mast cell stabilizing effect and a H1 antihistamine effect on allergic problems [21].

Radio sensitizing activity

The radio sensitizing activity of dichloromethane extract of *T. cordifolia* in the mice transplanted with Ehrlich ascites carcinoma (EAC) was investigated by S.K. Rao (2008). The EAC mice received various doses of TCE 1 hour before exposure to 6 Gy hemi-body γ -radiation, and then once daily for eight days after irradiation. According to investigators, the mice showed a dose-dependent elevation in tumor-free survival. Treatment of animals with TCE increased the life length of EAC mice. Evaluation of glutathione (GSH), glutathione S-transferase (GST) and lipid peroxidation (LPx) in mice treated with TCE showed a significant reduction in GSH up to 14 hours and GST up to 24 hours, and a significant elevation in LPx at 12 h post-irradiation. The researchers suggest that the radio sensitization of TCE may be as a result of reduction of glutathione and glutathione-S-transferase, together with increased levels of lipid peroxidation and DNA damage of tumor cells [22].

Effect on gamma ray-induced perturbation

Singh (2007) studied immuno-competence, which are unfavorably affected by irradiation. Their study included evaluation of cell count, DNA fragmentation, spleen size, and apoptosis in splenocytes. The adherence, spreading and phagocytic activities of macrophages, and also cytokines in serum and antioxidants in plasma were evaluated. According to investigators, administration of *T. cordifolia* extract (TCE) 1 hour before irradiation showed recovery of spleen weight from 49% of control in irradiated group to 93%; apoptosis from 19% to 2.8%; DNA fragmentation from 43% to 20.4%; macrophage adherence from 75% of control to 120% and macrophage spread size from 8 to 15 micron. TCE also dose-dependently stimulated proliferation in splenocytes. Administration of TCE before irradiation also improved levels of IL-1 β and GM-CSF. It seems that TCE is radio-protective by several mechanisms [24].

Re-establishment of antioxidant defence

A study examined the effect of oral administration of an alcoholic extract of *T. cordifolia* roots on antioxidant defence in alloxan-induced diabetes in rats. According to investigators it increased significantly the concentration of thiobarbituric acid reactive substances in diabetic rat's liver and kidney. Reduced concentration of glutathione and decreased activity of superoxide dismutase and catalase in liver and kidney of diabetic rats were also distinguished. Results of the study showed that the extract of *T. cordifolia* which was given to diabetic rats orally for six weeks, normalized the antioxidant status of liver and kidney. The investigators say that effect of extract was more potent than glibenclamide [23].

Antiosteoporotic potential

A study investigated the potential antiosteoporotic effect of *T. cordifolia* ethanolic stem extract. The researchers chose female Sprague-Dawley rats which either ovariectomized (ovx) or sham operated, and treated with vehicle (benzyl benzoate:castor oil; 1:4), E(2) or TC. Then they measured bone mineral density of tibiae by quantitative computer tomography. They also analyzed serum for levels of osteocalcin, the activity of alkaline phosphatase, and lipids. *P. Kapur* observed that administration of *T. cordifolia* showed an osteoprotective effect compared to control. According to researchers, serum osteocalcin and cross-laps levels were significantly reduced. Although these effects of *T. cordifolia* were not as significant as those produced by E(2), but alkaline phosphatase activity was higher in *T. cordifolia* treatment groups. Total cholesterol and LDL levels were unaffected but HDL levels were considerably reduced with *T. cordifolia* administration. As the researchers observe, *T. cordifolia* extract showed estrogen-like effects in bone but not in reproductive organs like mammary gland and uterus [30].

Clinical studies and therapeutic activities

Immunostimulation activity

Immunostimulation is a known pharmacotherapeutic intervention in disease management. V. A. Badar (2004) has studied the immunostimulation of *Tinospora cordifolia* extract. They observed that it considerably decreased symptoms of allergic rhinitis like nasal discharge, sneezing, nasal pruritus and nasal obstruction. The researchers confirmed efficacy of *T. cordifolia* by nasal smears cytology, leukocyte count and clinical findings. As the study shows, *T. cordifolia* can be a considerable treatment of allergic rhinitis because of its high efficacy, tolerability and lack of major side effects and reactions [20].

M, V. Kalikar (2008) in another study investigated the safety and efficacy of *T. cordifolia* in human immunodeficiency virus positive patients. Efficacy of the extract in HIV positive patients was assessed in randomized double blind placebo controlled trial. According to investigation, 68 HIV positive participants in two groups received either TCE or placebo for six months. They counted platelet count, TLC, DLC, ESR, hemoglobin and CD4 after clinical examination. The hematological investigations were repeated at bimonthly intervals and CD4 count was repeated at the end of the study. According to results of this study, the extract treatment caused considerable decrease in eosinophil count and hemoglobin. 60% of patients receiving the extract and 20% of placebo receivers had reduction in the occurrence of symptoms associated with disease. Some of the common side effects reported by patients on *T. cordifolia* extract were vomiting, anorexia, nausea, and weakness. Since this study was validated by clinical evaluation, the researchers conclude that *Tinospora cordifolia* could be used in HIV/AIDS management [31].

N. Rege (1993) evaluated the effect of TC on surgical outcome in patients with malignant obstructive jaundice. Thirty patients were divided into two groups, impairment of hepatic function and immunosuppression. First group received conventional management, antibiotics, vitamin K and biliary drainage. Second group received the same plus *T. cordifolia* in addition. According to researchers, although it was observed that hepatic function didn't changed in the two groups after drainage, however, the phagocytic and killing ability of neutrophils returned to normal in the second group's patients. After the drainage was bactobilia occurred in 8 patients in first group, and 7 in the second one. The results of the study also show that septicemia was observed in 50% of patients in first group, but 0% in the second group. It was also observed a significant difference in Post-operative survival in groups: 40% in the first one and 92.4% in the second one. N. Rege concluded that *T. cordifolia* is capable to develop

surgical outcome by increasing immune defenses. [32] Another clinical study was undertaken by N. Rege to determine the immunomodulator effect of *T. cordifolia*. The results of the study showed that water extract of *T. cordifolia* improved the cellular immune functions. The researchers concluded that cholestasis results in immunosuppression, and thus pointed to the need for an immunomodulator in treatment of obstructive jaundice. *T. cordifolia* according to this study seems to be useful in modulating defence mechanism [33].

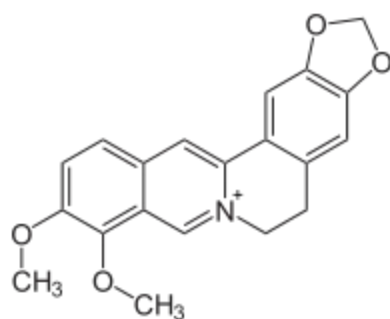
Side effects and toxicity

Tinospora cordifolia is one of the essential medicinal plants used in system of medicine for the management of various diseases. In some studies the genotoxic risk of the aqueous extract of *T. cordifolia* has been evaluated. According to researchers results confirmed that in Ames test up to 5000 µg/plate of *T. cordifolia* did not show any mutagenic ability in *Salmonella typhimurium* mutant strains. They observed also in CA assay, *T. cordifolia* had no clastogenic effect to human peripheral blood lymphocytes up to a concentration of 3000 µg/ml. In MN and Comet assays, the researchers administrated *T. cordifolia* for 7 days at three dose levels (150, 200 and 250 mg/kg body weight) orally to mice. The results demonstrated that *T. cordifolia* administration had not clastogenicity and DNA damaging ability in peripheral blood lymphocytes and bone marrow erythrocytes respectively [25].

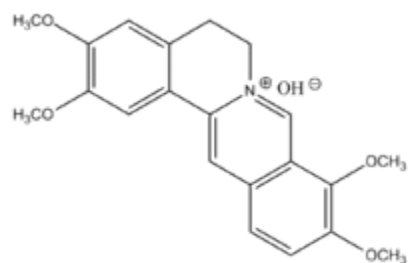
Conclusion

There has been an increase in demand for the Phytopharmaceutical products of Ayurveda in Western countries, because of the fact that the allopathic drugs have mostly more side effects. Many pharmaceutical companies are now concentrating on manufacturing of Ayurvedic Phytopharmaceutical products. *Tinospora cordifolia* has been used for centuries for treating various diseases in Ayurvedic system of medicine. It has showed no side effect and toxicity. Although there is still no scientific evidence of stomachic or cholagogue effect of *T. cordifolia*, there are many studies supporting that *T. cordifolia* has hypolipidaemic effect, antineoplastic action, activation of neutrophils ability, immunostimulatory and immunomodulatory property and improves the cellular immune functions, capable of inducing apoptosis, reduces the solid tumor volume, useful in treatment of acute and chronic allergic disorders, capable of inducing apoptosis in EAT cells and proapoptotic effect on tumor cells, activation of macrophages, affect the symptoms of HIV, estrogen like effects in bone, hypolipidaemic effect, decreases HDL cholesterol levels and increases LDL and VLDL cholesterol levels, and the radiosensitizing activity. Thus, it seems that *T. cordifolia* has the potential for being used as an efficient medicine in the future.

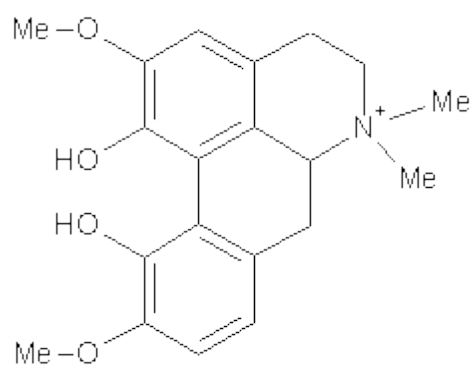
Chemical structures



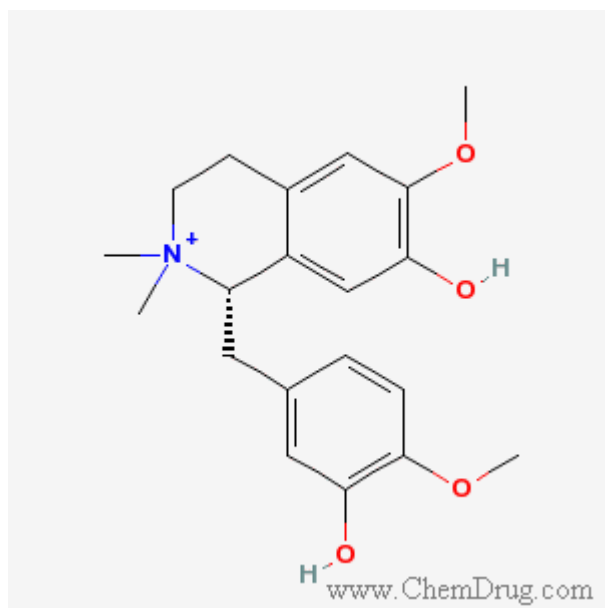
Berberine



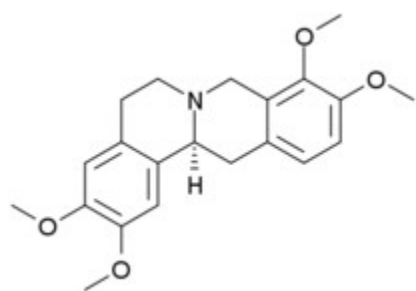
Palmatine



Magnoflorine



Tembetarine



Tetrahydropalmatine

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<http://www.neeroga.com/giloeherb.aspx>

4 *ANTIARIS TOXICARIA* LESCH.



Introduction

Family	<i>Moraceae</i>
Butanical name	<i>Antiaris toxicaria</i> Leschen.
Burmese name	Hmyasceik, aseik
Parts of plant used	Latex
Claimed medicinal Properties	Heart tonic, febrifuge (arrow poison) [1]

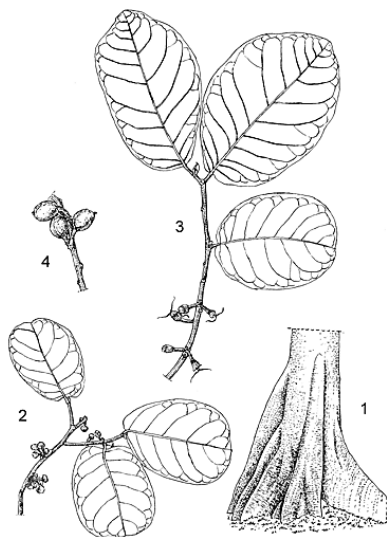
Arrow poisons have been used for at least 2500 years in various parts of the world. Foersch, a surgeon in the service of the 'Dutch East India Company' in about the year 1780, says that when criminals received sentence of death, were offered the chance of life. They should go to the Upas tree for a box of poison. And although every safety measure was taken to avoid the harmful influence of the emanations of the tree, yet of 700 criminals who went to gather the poison, hardly two out of twenty returned [2].

Antiaris toxicaria is a magnificent deciduous tree. In Java it flowers in June. The soft fruit is scattered by birds, bats, monkeys, and antelopes. The fruit is edible. The wood provides only small amounts of fuel. Bark has tannins and is employed in dyeing [2] [3] [4].

Figure 1:

1, base of bole; 2, twig with male inflorescences; 3, twig with female inflorescences; 4, part of fruiting twig.

Redrawn and adapted by Iskak Syamsudin [4]



Synonym names

Searching whole name *Antiaris toxicaria* in all records in IPNI (international plant names index) gives 2 results:

- ☐ Moraceae *Antiaris toxicaria* Lesch. -- Annales du Mus?um National d'Histoire Naturelle 16 1811 (APNI)
- ☐ Moraceae *Antiaris toxicaria* Lesch. -- Ann. Mus. Natl. Hist. Nat. xvi. (1810) 478. (IK)

Synonyms:

Antiaris africana Engl.

Antiaris macrophylla R.Br.

Antiaris welwitschii Engl.

Common names:

(English) : bark cloth tree, antiaris, false iroko, false mvule, upas tree

(Filipino) : upas

(Indonesian) : bemoe

(Javanese) : ancar

(Malay) : antiaris, antjar

(Mandinka) : jafo

(Swahili) : mkunde

(Thai) : yang yong

(Wolof) : kan, man

Other common names: Aseik, Hkang-awng, Hmya-seik [4] [5].

Results of searches in literature

Searching the name of * *Antiaris toxicaria* * in Google scholar resulted 1220 results, meanwhile the same search plus *medicinal* resulted 447 results, 2 February 2011.

Searching the name in Pub Med found 14 results, in the ISI WEB OF KNOWLEDGS 46 results, 2 February 2011 and in SciFinder (after removing duplicates) resulted 103 results (29 January 2011). It may illustrate the popularity of the plant in researches.

Family of *Moraceae*

Moraceae, the mulberry family of the rose order (Rosales), has about 40 genera and some 1,000 species of deciduous or evergreen trees and shrubs. It is distributed frequently in tropical and subtropical regions. Species of the family contain a milky latex and have alternate or opposite leaves and small, petal-less male or female flowers. The fruits of most species are multiple because fruits from different flowers become joined [24].

Morphologic description

A. toxicaria is found from dry to wettest types of forest and even in wooded grassland. It is habitually common in secondary forest, and is a developing tree of the high forest. In the wetter types of forest, it prefers well-drained sites. *A. toxicaria* can be found from sea level to 1800 m altitude [4]. It is a deciduous, small to large tree up to 45(60) meters tall, branchless for up to 25(33) meters and up to 180 cm in diameter. Bark surface is smooth, greyish white to greyish green, with many lenticels. Inner bark is soft and fibrous, exuding creamy latex soon darkening to dirty brown. Leaves are alternate, mostly distichous and simple. Flowers are unisexual. Fruit forming is drupe-like, ellipsoid to ovoid or globose entity with the enlarged, fleshy orange to scarlet receptacle, 1 to 2 cm long and 1-seeded [4].

Traditional medicinal use

The bark latex is one of the principle parts of most dart and arrow poisons in South-East Asia. The latex yield of a scarred tree may be 100 to 500 g in 2 days. In Africa the latex is applied to cuts, wounds and skin diseases such as eczema and leprosy. It is taken internally as a cathartic. It is also used as fish poison and birdlime. Seeds, leaves and bark are used as a febrifuge and the seeds also as an antidysenteric. The bark is used as a soothing and vermifuge, and to treat hepatitis. It has also been reported to been used for dyeing. The inner bark is used to make rough clothing and paper. The leaves and root are used to treat mental illnesses. The leaves are also used as fodder. *A. toxicaria* is sometimes planted as a roadside tree because it has dense shade [1] [4] [5].

Phytochemistry and chemiCal structures

Jiang (2009) reported that Antiarisin A and B (figure 3), and seventeen other compounds (3-19) (figure 2) were isolated from the EtOAc extract of the stem of *A. toxicaria* [6].

Figure 2: Structures of 1–19 [6]

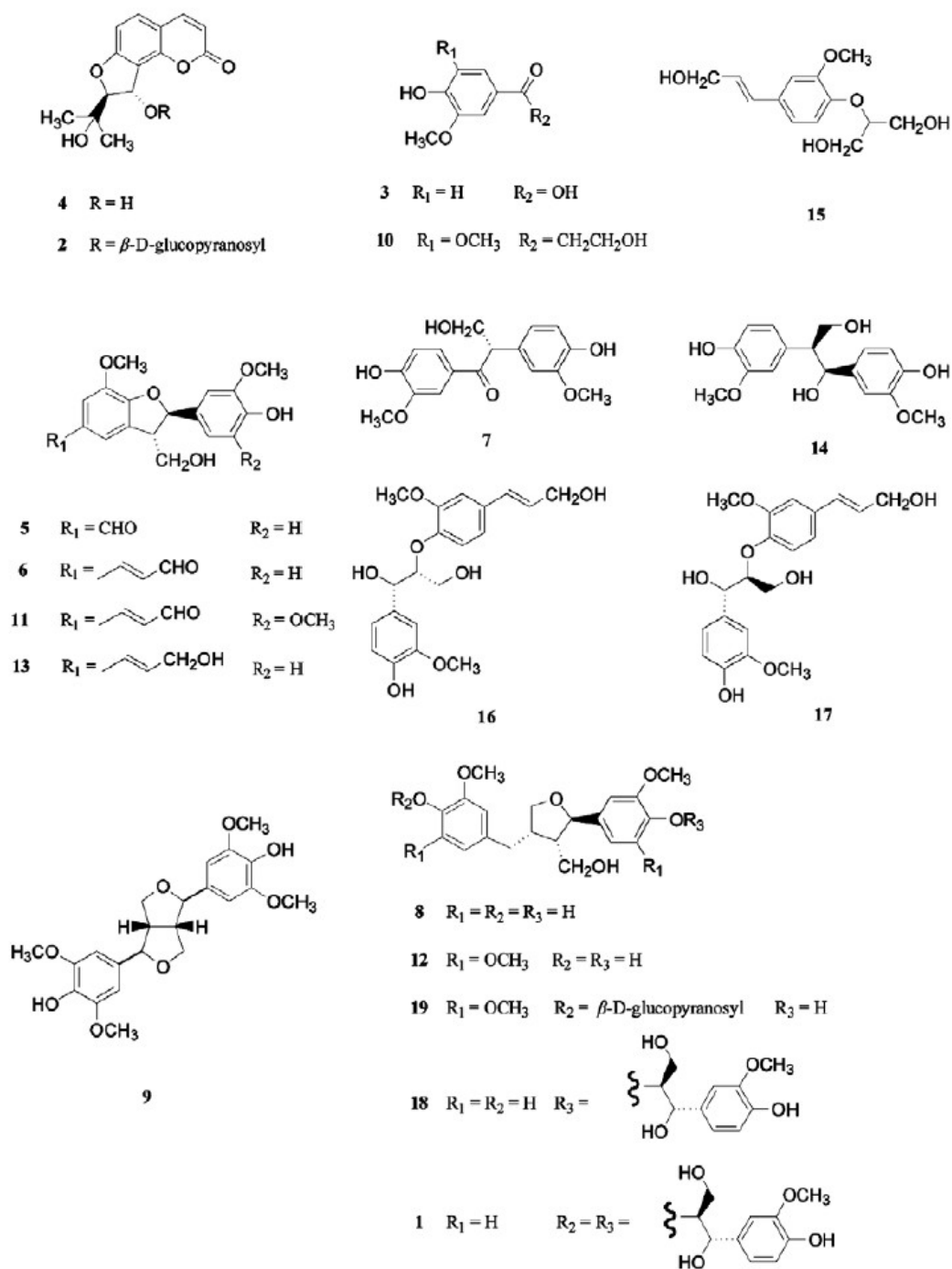
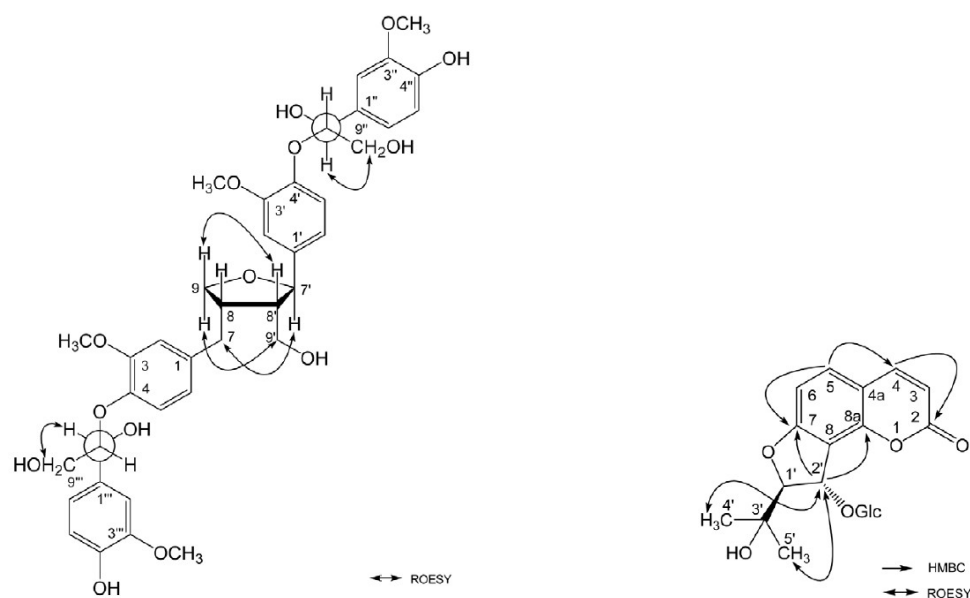


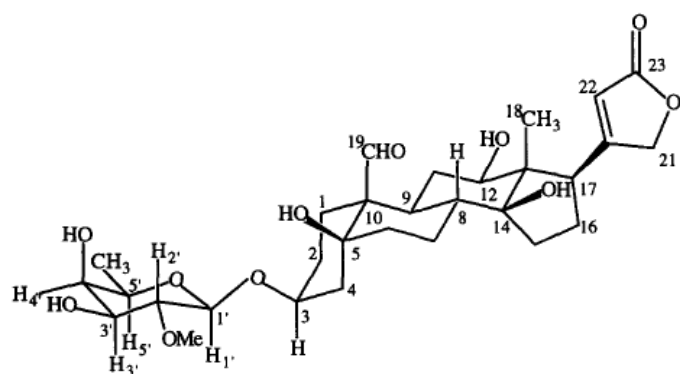
Figure 3: **Left:** Key ROESY correlations of antiarisin A

Right: Key HMBC and ROESY correlations of antiarisin B [6]



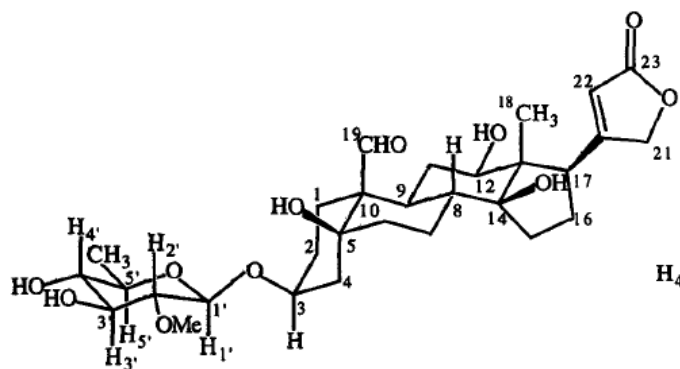
Three cardenolides, named toxicarioside A (*figure 4*), toxicarioside B and toxicarioside C (*figure 5*) were isolated by Carter (1997) from latex of the plant [19] [20]. Toxicarioside D (*figure 6*) was isolated from the stem [8]. Other cardenolides, named toxicarioside E, toxicarioside F (1) and toxicarioside G (2) (*figure 7*) were also isolated from the latex by Gan (2009) [14]. A nor-cardenolide, named toxicarioside H, was also isolated from the EtOAc extract of latex by Dai (2009) [13].

Figure 4: [20]

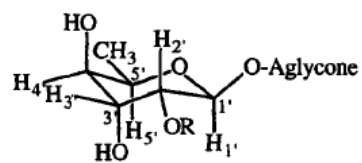


1, toxicarioside A
sugar = 2-O-methylfucose

Figure 5: [19]

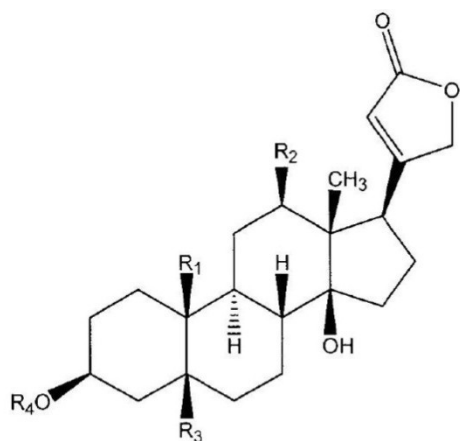


2, toxicarioside B
Aglycone = antiarigenin
sugar = 6-deoxy-2-O-methylglucose



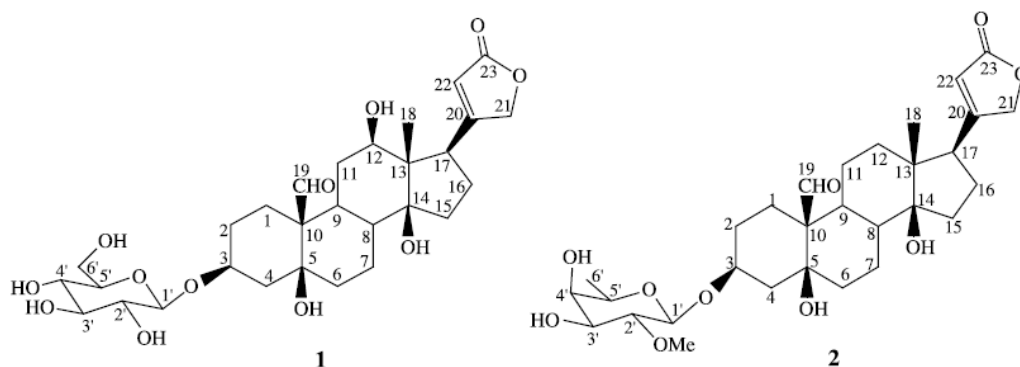
3, toxicarioside C
R = CH₃, Aglycone = antiarigenin
sugar = 6-deoxy-2-O-methylglucose
5, α-antiarin
R = H, Aglycone = antiarigenin
sugar = β-6-deoxygulose

Figure 6: [8]



$R_1 = \text{CHO}$, $R_2 = \text{H}$, $R_3 = \text{OH}$, $R_4 = 6\text{-deoxy-2-O-methyl-}\beta\text{-glucopyranosyl}$

Figure 7: Toxicarioside G



Antiarones A and B are the first samples of isoprenylated aurone derivatives isolated by Nomura (1994) from the plant. The chalcone derivatives antiarones C, D and E and the flavanone derivatives antiarones F, G, H and I from the plant have an isoprenyl group at the mentioned position of the B ring in the skeleton [9]. Two other dihydrochalcone derivatives, antiarones J and K, were isolated from the MeOH extract of the root bark by Hano (1991). Antiarones J and K were considered as chalcone derivatives having an isoprenoid functional group at the C-2 position [22] [25].

Shi (2010) noted that an ethanolic extract of *Antiaris toxicaria* trunk bark shows potent *in vitro* cardiotonic effect on isolated guinea pig atria. The researcher's investigation led him to identification of nine new cardiac glycosides (1 to 9, named antiarosides A to I) and antiarotoxinin A (figure 8) [12].

Figure 8: [12]

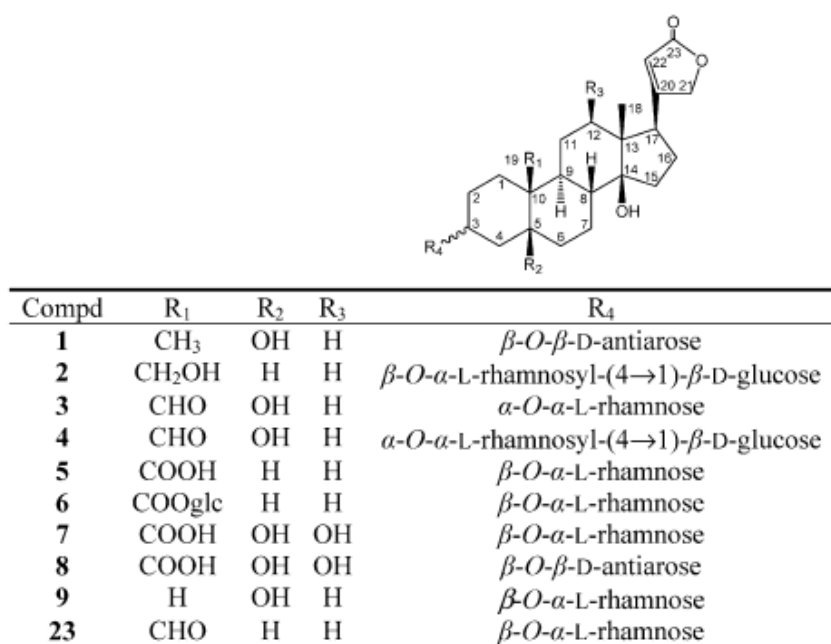
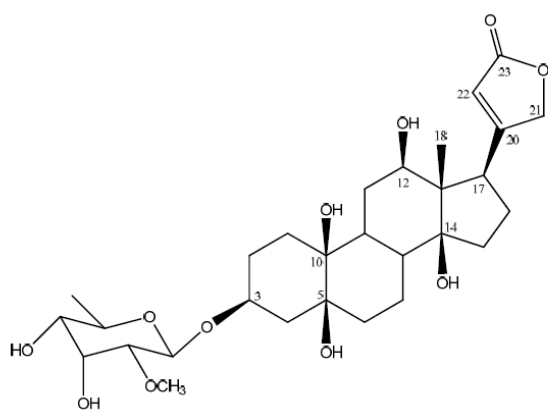


Figure 9: [13]

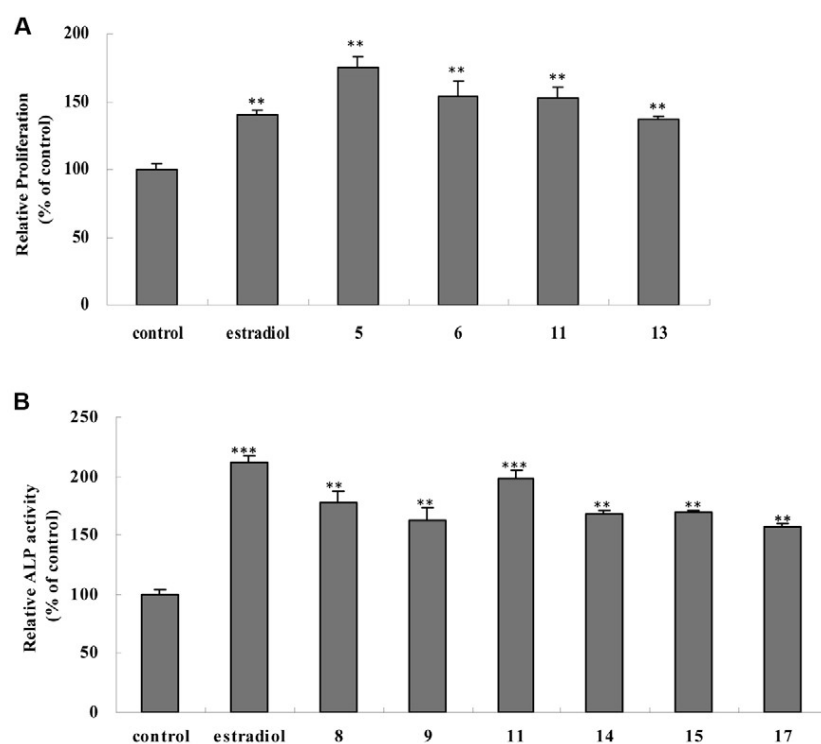


Bioactivity

Effects on proliferation and differentiation on osteoblast-like cells

Antiarisin A and B and seventeen other compounds (1 to 19, *figure 2*) were isolated from the EtOAc extract of the stem. Jiang (2009) studied them for their proliferative and differentiative activity on osteoblast-like cells. The researcher reported that lignans 5, 6, 11 and 13 had significantly stimulating effect on proliferation of UMR106 cells, while 8, 9, 11, 14, 15 and 17 increased the alkaline phosphatase activity. Jiang suggests that these lignans may be potential candidates for treatment of osteoporosis without unwanted oestrogen-like side effects [6].

Figure 10: Effects of compounds **5**, **6**, **11** and **13** on the proliferation of UMR106 cells (**A**) and **8**, **9**, **11**, **14**, **15** and **17** on ALP activity (**B**) at 10⁻⁸ M. Estradiol was used as the positive control. Each symbol and bar shows the mean \pm S.D. of the experiments, and mean value is significantly different (** $p < 0.01$, *** $p < 0.001$) from the control [6].



Cytotoxicity and anticancer effect

Dai (2009) isolated toxicarioside F (1) and toxicarioside G (2) (Table 2) from the latex of the plant. According to Dai both of them showed notable cytotoxicity against the human myeloid leukaemia cell line (K562), human gastric cell line (SGC- 7901), human hepatoma (SMMC-7721), and human cervical cancer (HeLa) *in vitro* by the MTT method [7].

Table 2. *In vitro* cytotoxicities of compounds 1 and 2 (IC₅₀ values, µg/ml).

Compounds	K562	SGC-7901	SMMC-7721	HeLa
1	0.020	0.006	0.001	0.002
2	0.044	0.010	0.009	0.013
Mitomycin C ^a	7.1	8.8	2.2	6.3

Note: ^aPositive control.

Uno (1992) and Dai (2009) also studied and reported anticancer activities of the plant [15] [18] [21]. Yao (2008) reported that cardiac glycoside compounds of the plant could stimulate the nuclear receptor TR3 to express. The researcher concluded that these compounds had potency to be used in preparation of drugs which prevent and treat cancer, hepatitis and atherosclerosis [16]. Jiang (2008) reported that toxicarioside D effectively inhibited the growth of various cancer cell lines, and induction of the expression of a potent apoptotic member of the steroid/thyroid hormone receptors, named Nur77 [8].

Effects on blood pressure and electrocardiogram

The ethanolic extract of trunk bark studied by Shi (2010) and showed potent cardiotonic effect on isolated guinea pig atria *in vitro* [12]. Fujimoto (1983) had already researched the crude sap earned from the *A. toxicaria*. He gave it to anaesthetized rats, and followed changes in electrocardiogram and systemic blood pressure. According to results, a dose of 0.6 g per kg resulted temporary hypertension. A dose over 0.8 g per kg resulted hypotension after the temporary hypertension. Finally in the dose of 1.5 to 1.8 g per kg the blood pressure fell to zero. The main components of the sap are known as cardiac glycosides, and the glycosides

affect Na^+ , K^+ -ATPase activity of muscle membrane and heart muscle contraction (*figure 11*) [11].

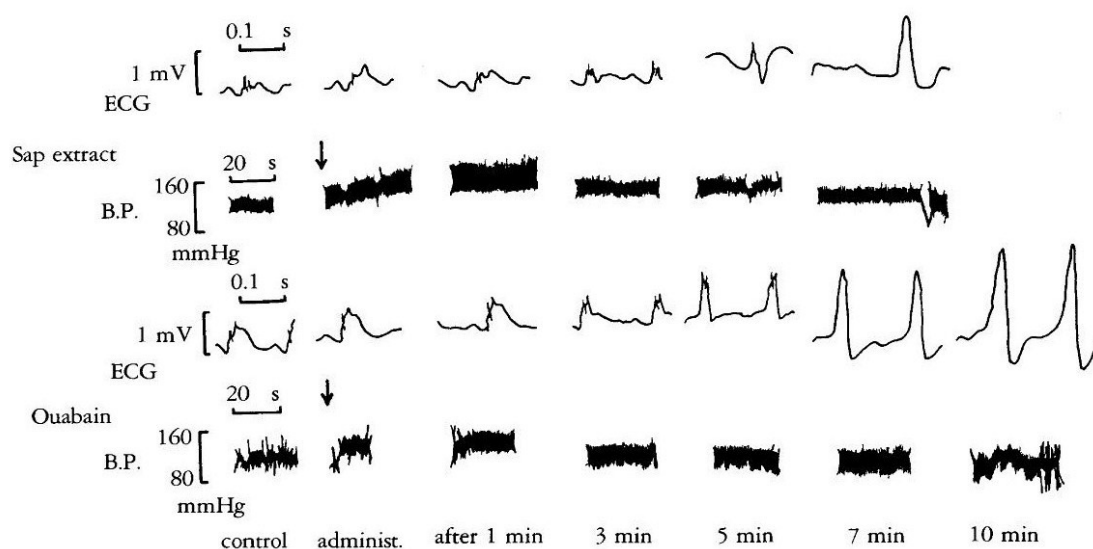


Figure 11: Electrocadiogram (ECG) and blood pressure (B.P.) following administration of the sap and ouabain [11].

Antioxidant activities

Gan (2008) reported the liposoluble fraction of *A. toxicaria* latex had antioxidant activity by 2,2-diphenyl-1-picrylhydrazyl (DPPH) free radical scavenging method [17]

Clinical studies

No clinical study has been found about *Antiaris toxicaria* so far.

Side effects and toxicity

A. toxicaria have been used as arrow poison for at least 2500 years. The main active components of latex from bark are cardenolides [10]. Some plant and animal species use cardenolides as a defence mechanism. Cardenolide glycosides are often toxic. They cause heart-arresting. Sheng-li (2008) reported that the leaves of *A. toxicaria* in oral administration showed no sign of toxicity in mice. [26]. The fruit is edible.

Conclusion

Latex from *Antiaris toxicaria* has ability to make changes in electrocardiogram and systemic blood pressure. There are researches suggesting that cardiac glycosides of the plant have also potent cardiotonic efficacy [12], anticancer activity and antioxidant activity. However no direct scientific evidence was found to prove the febrifuge efficacy of the plant so far. It is needed more clinical studies about these effects.

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Pictures references

Guangdong Southern support base for Chinese herbal medicines seed
<http://gdctm.com.cn/ArticleShow.asp?ArticleID=148>

5 *ENTADA PHASEOLOIDES* MERR.



Introduction

Family	<i>Leguminosae</i>
Butanical name	<i>Entada phaseoloides</i> Merr.
Burmese name	Gon-nyin
Parts of plant	Seeds
Claimed medicinal Properties	Fish poison, emetic etc. [1].

Entada phaseoloides grows at low and medium altitudes from near sea level to 100 meters in beach forest, gallery forest, monsoon forest and lowland rainforest. Young leaves of the plant are eaten, raw or cooked In the Dutch Indies. The seeds after certain treatment are eaten in Bali and Sumatra. Pod and seeds are used as coffee substitute in South Africa. This species has also been used medicinally in India, Malaysia, the Philippines, Java and many other lands. It is used widely in the Philippines and other countries for washing the hair and an ingredient of hair tonics. The bark is used as cordage, for tinder and for making matchboxes in Europe. Large pods and seeds used by children as playthings. The oil extracted from the seeds used as illuminant in the Sunda Islands. It is also reported using seeds for snuff in Europe [2] [3].

Synonym names

Searching in IPNI (international plant names index) gives 2 results:

- Leguminosae *Entada phaseoloides* Merr. -- Philipp. J. Sci., C 9: 86. 1914 (IK)
- Mimosaceae *Entada phaseoloides* (L.) Merr. -- Philippine Journal of Science C. Botany 9 1914 (APNI)

It has also been named as:

Entada scandens (L.) Benth., *Hooker's Journal of Botany* 4: 332(1841).

Lens phaseoloides L. in *O.Stickman, Herb. Amoin.*: 18(1754) [2][4].

Other common names: St. Thomas bean, Water Vine, Matchbox Bean, Vine, Gogo, Matchbox Bean, Elva Climber, Climber, Elva, Elva Climber, Vine, Go-go, Go-go Vine, Bean, Matchbox, Gogo Vine [2] [4].

Results of searches in literature

Searching the name of **Entada phaseoloides** in Google scholar resulted 518 results, meanwhile the same search plus **medicinal** resulted 140 results, 22 January 2011.

Search for "Any word= *Entada phaseoloides* "in "Articles" in X-port found 1 result, in Pub Med found 4 results, and in the ISI WEB OF KNOWLEDGS resulted 41 results, January 2011. It may show the popularity degree of the plant in researches.

Family of *Leguminosae* -The Pea Family

Legumes, the third largest flowering plant family, are an important ingredient of nearly all terrestrial biomes, on all continents (except *Antarctica*). The legume (or bean) family, which includes lentils, peas, beans, peanuts and soya, is important as a source of food because of its high protein content. These species range from dwarf herbs of arctic and alpine vegetation to massive trees of tropical forest. Many legumes are capable to fix atmospheric nitrogen in association with root bacteria or species of fungi. This tactics allows them to colonizing and growing in even the poorest soils, even as also helping to develop them. The main feature of the family is the fruit, a peapod which officially is known as a Legume. The Legume is adapted in many ways to make possible spreading by wind, animals and water. According to Bisby, the family is divided into three subfamilies:

Papilionoideae, *Caesalpinioideae* and *Mimosoideae*. Sometimes these subfamilies are documented as three separate families. The three subfamilies are usually recognizable by their flowers. The *Mimosoideae* are mostly tropical or subtropical trees and shrubs characterized by their small, regular actinomorphic flowers which are. The stamens are maybe the most beautiful part of the flower, the five not immediately obvious petals. The leaves have double pinnate leaflets [5].

Morphologic description

Entada phaseoloides is a large, wooden high climbing species, up to more than 40 meters.

Stem: The stems are harsh, angled, laterally compressed or packed down and twisted like a corkscrew. Stem diameters to 18 (25) cm recorded. Bark is dark-brown and rough.

Leaves: Leaves are bipinnate with 8 to 16 leaflets (two to four leaflets on each secondary axis) main rachis looks like a branched tendril beyond the leaf. Leaflet blades are about 4 to 11 x 2.5 to 5.5 cm, leaflet stalks are about 0.1 to 0.7 cm long, in a criss-cross formation wrinkled. Lateral veins forming loops well inside the blade margin. In the leaflet blades there are scattered large clear glands visible to the naked eye, many smaller glands visible with a lens.

Leaflets: Leaflets are oblong or obovate, opposite, up to 10 x 6 cm, rigidly leathery, edge smooth and glossy dark-green. Stalklets are short.

Flowers: Flowers are 2 to 3 mm long, almost cup-shaped, about 1.5 mm diameter at the apex, corolla pink to red on the outside, and inside is cream or semi-transparent. Petals are about 3 x 1 to 1.5 mm. Staminal filaments are crumpled in the bud. Filaments are about 6 to 7 mm long at florescence.

Fruits: Fruits are flattened, about 88-100 x 9-12 cm, compressed at intervals and divided into about 12 segments. Each segment is about 7 x 9 to 10 cm, bordered by endocarp and falling from the pod leaving only the sutures of the pod attached to the vine. Epicarp is shed by rolling up into rolls of tissue. Endocarp is not hard, almost leathery or like parchment.

Pods: Pods are few, suspended, 30 to 100 cm long and 7 to 10 cm wide, almost bent, slightly constricted between the seeds.

Seeds: Seeds are hard, and circular, with their sides flattened, about 5 cm across and 1-1.5 cm thick, and glossy chocolate dark-brown. The testa is also hard [2] [3] [6].

Traditional medicinal use

Useful parts of the plant are bark, seeds and vines. The vines may be collected during any time of the year. The seeds may be collected from January to April [3]. *E. phaseoloides* is been used for a verity of remedies:

Dried vine decoction materials are used for rheumatic lumbar and leg pains, sprains and bruises.

Powdered seeds is taken (orally with water) for jaundice, and edema due to malnutrition. It used also as emetic, febrifuge and cure for cerebral haemorrhage. The seeds are also used as a fish poison. In India, ground seeds are used internally for snake bites, contraception and as aphrodisiacs. Pounded kernels of the seeds (mix with oil) apply as plaster for abdominal pains and colic. A paste of the seeds applies for counterirritant to glandular swellings in the axilla, loins and joints, and swollen hands and feet. Seeds have also been used as hair growth stimulant. A decoction of the bark used for washing skin areas affected by itches. Stem macerated in cold water used as an emetic. It makes a cleansing soap; also [1] [2] [3] [7] [8].

Phytochemistry and chemical structures

Ikegami (1987), Baru (1988), Dai (1991), Grant (1995), Siddhuraju (2002) and Makkar (2007) have managed some notable studies on *E. phaseoloides* seeds [7] [8] [9] [10] [11] [12]. Ikegami (1989) has also studied the content of the leaves of the plant [13]. The bark phytochemistry was studied by Okada (1987) [14]. The most important components of *E. phaseoloides* seeds are listed in *Tables 1, 2, 3 and 4* [7].

According to Siddhuraju the kernel contained 66.1% of the seed weight. The seed kernels contained 256.7 g/kg rough protein, 108.1 g/kg lipid, 27.3 g/kg ash and a notable component of carbohydrate as high as 585.7 g/kg. The quantities of phosphorus, potassium, zinc and iron were comparable to other seeds in this family. Albumins represented the major storage protein in seeds. The protein fractions were rich in essential amino acids, mainly sulphur containing amino acids. The kernel lipids comprised high levels of unsaturated fatty acids, oleic and linoleic acids (83% of the total fatty acids). The kernel showed high trypsin and chymotrypsin inhibitor activities. It contained also oligosaccharides, phytic acid, lectins and phenolics. A group of triterpenoid saponins was also detected which had high haemolytic activity against cattle erythrocytes. The kernel protein showed a low (67%) *in vitro* digestibility [7] [8].

Table 1: Physical characteristics of pods and seeds of E. phaseoloides

Characteristics	Value
Pod length (cm) ^a	55–90
Number of seeds per pod	5–11
Thickness of seed (cm) ^b	1.94±0.09
Thickness of seed kernel (cm) ^b	1.63±0.06
Diameter of seed (cm) ^b	4.14±0.12
Diameter of seed kernel (cm) ^b	3.80±0.10
Seed weight (g) ^b	18.41±1.14
Seed kernel weight (g) ^b	12.16±0.65 (66.05)
Seed coat weight (g) ^b	6.25±0.57 (33.95)
Seed colour	Dark brown

^a Values from 10 pods.

^b Values are mean of 30 seeds ± standard deviation.

Figures in the parentheses indicate percentage of seed weight.

Table 2: Proximate composition of *E. phaseoloides* seed kernel and seed-coat

Component	Seed kernel	Seed coat
Dry matter	945.5 ± 7.15	931.0 ± 6.20
Crude protein	256.7 ± 3.12	50.42 ± 1.84
Lipid	108.1 ± 4.26	0.943 ± 0.07
Ash	27.3 ± 0.81	20.1 ± 1.16
Crude fibre	22.3 ± 1.42	208.0 ± 11.03
NFE	585.7	720.6
Gross energy (MJkg ⁻¹ DM)	20.21	17.20

NFE, nitrogen-free extractives = 100 – (crude protein + crude lipid + ash + crude fibre).

DM, dry matter basis.

Values are mean of triplicate determination ± standard deviation.

Table 3: Total protein, protein fractions and mineral composition of *E. phaseoloides* seed kernels (DM)

Component	g kg ⁻¹ seed kernels	g kg ⁻¹ seed kernel protein
Total protein	229.84	
Protein fractions		
Albumins	160.2 ± 7.3	697.0
Globulins	58.0 ± 3.1	252.3
Prolamins	2.51 ± 0.2	10.9
Glutelins	9.14 ± 0.2	39.8
Mineral composition (mg kg ⁻¹ DM)		
Calcium	1036.2 ± 21.1	
Phosphorus	3998.1 ± 12.6	
Potassium	12915.4 ± 31.7	
Magnesium	342.7 ± 11.2	
Sodium	266.3 ± 5.3	
Iron	49.2 ± 2.01	
Zinc	20.8 ± 1.7	
Copper	10.3 ± 0.63	
Manganese	5.29 ± 0.24	

Values are mean of duplicate determination ± standard deviation.

DM, dry matter basis.

Table 4: Amino acid composition and essential amino acid score of total, albumin and globulin proteins of *E. phaseoloides* seed kernels, FAO/WHO (1990) recommended allowances, soybean and hen egg

Amino acid	Seed kernel flour	EAA score	Albumins	EAA score	Globulins	EAA score	Soybean ^a	FAO/WHO value ^b	Hen egg ^c
Aspartic acid	8.71		8.55		7.42		11.30		
Threonine	3.44	101.10	3.13	92.06	2.94	86.47	3.76	3.40	4.70
Serine	5.19		4.72		4.53		5.67		
Glutamic acid	12.42		13.21		13.31		16.90		
Glycine	5.23		4.43		4.52		4.01		
Alanine	3.79		3.23		3.73		4.23		
Cystine	2.03	231.24	1.54	207.20	1.31	117.60	1.70	2.50 ^d	5.70 ^d
Methionine	3.75		3.64		1.63		1.22		
Valine	4.69	133.92	3.90	111.43	3.81	108.86	4.59	3.50	6.60
Isoleucine	4.22	150.66	3.78	135.00	3.29	117.50	4.62	2.80	5.40
Leucine	6.99	105.94	5.91	89.55	7.10	107.58	7.72	6.60	8.60
Tyrosine	5.23	161.82	4.34	137.78	3.80	141.11	3.39	6.30 ^e	9.30 ^e
Phenylalanine	4.96		4.34		5.09		4.84		
Histidine	3.79	199.41	3.78	198.95	2.76	145.26	2.50	1.90	2.20
Lysine	7.73	133.34	7.43	128.10	6.57	113.28	6.08	5.80	7.00
Arginine	6.52		4.17		4.89		7.13		
Proline	4.34		3.46		3.64		4.86		
Tryptophan	1.05	95.45	1.39	126.36	1.19	108.18	1.24	1.10	1.70
Limiting amino acid									
I	Tryptophan		Leucine		Threonine				
II			Threonine						

^a Ref 23.

^b Data from FAO/WHO²² reference pattern of amino acid requirement for pre-school children (2–5 years old).

^c Ref 24.

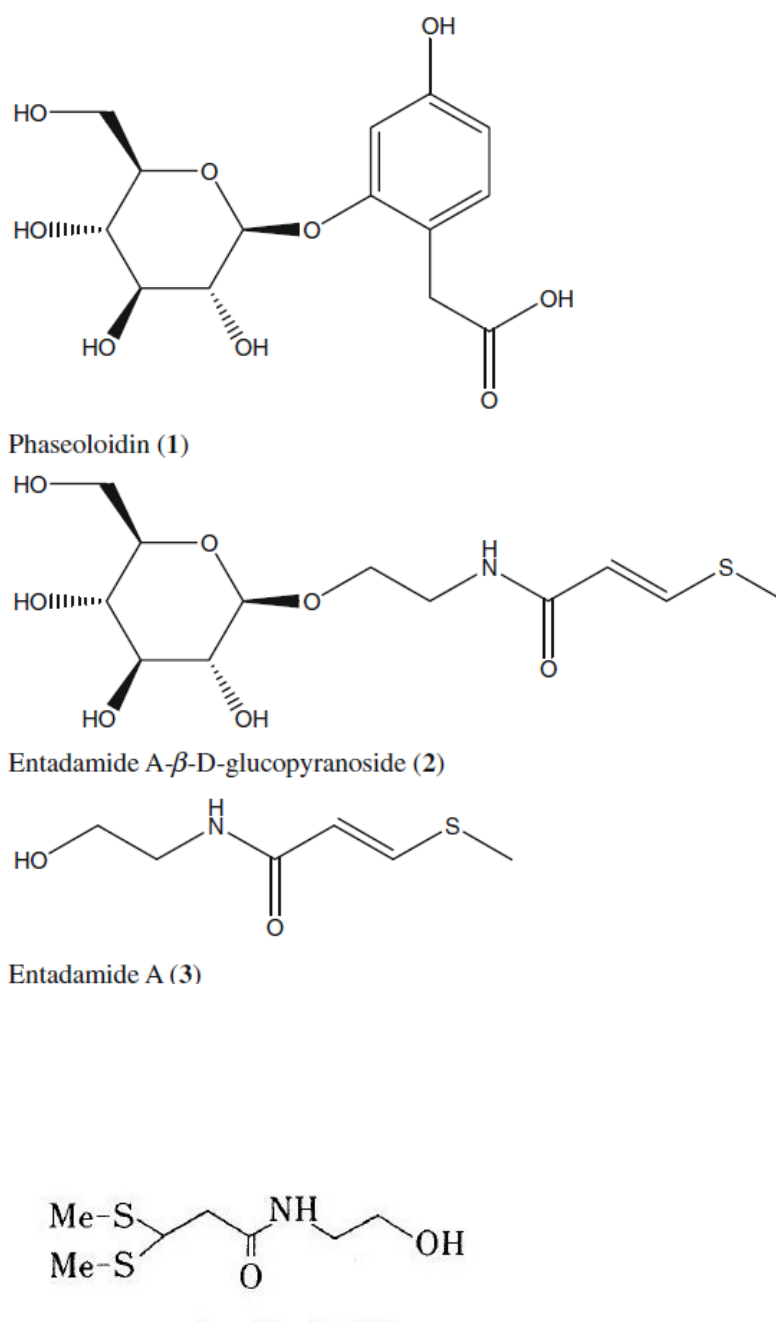
^d Cystine + methionine.

^e Tyrosine + phenylalanine.

Other studies explained some other components. Phascoloidin isolated and the structure characterized as homogentisic acid 2-*O*- β -D -glucopyranoside from seeds of *E. phaseoloides* by Baura (1988). Four other compounds including 2-hydroxy-5-butoxyphenylacetic acid, 2- β -d-glucopyranosyloxy-5-butoxyphenylacetic acid, entadamide A- β -d-glucopyranoside, and 2,5-dihydroxyphenylacetic acid methyl ester, have been isolated and characterized by Dai (1991). To sulphur containing amides, entadamide A and B, have also been detected by Ikegami (1987) [10] [11] [12]. The third sulphur containing amide, entadamide C (together with entadamide A) was isolated from the leaves [13]. Okada (1987) studied saponins of *E. phaseoloides* bark and characterized the structure of Entada saponin (ES)-III. It recognized to be 3-*O*-[β -d-xylopyranosyl (1 \rightarrow 2)- α -l-arabinopyranosyl (1 \rightarrow 6)] [β -l-glucopyranosyl (1 \rightarrow 4)]-2-acetamido-2-deoxy- β -l-glucopyranosyl-28-*O*-[β -l-apiofuranosyl (1 \rightarrow 3)- β -d-xylopyranosyl (1 \rightarrow 2)] [(2-*O*-acetoxyl)- β -d-glucopyranosyl-(1 \rightarrow 4)] (6 - *O*(*R*) (-)2,6-dimethyl-2-*trans*-2,7-octadienoyl)- β -d-glucopyranosyl echinocystic acid [14]. The last study managed by Hui (2010), determined four sulphur containing amide compounds. Seeds were

extracted with 70% ethanol at room temperature. The compounds were isolated from the n-BuOH soluble fraction and recognized as: entadamide A- β -D-glucopyranosyl-(1 \rightarrow 3)- β -D-glucopyranoside (1), entadamide A (2), entadamide A- β -D-glucopyranoside (3) and clinacoside C [15]. (Figure 1)

Figure 1: The structure of three major components of *E. phaseoloides*: phaseoloidin, entadamide A and entadamide A- β -D-glucopyranoside [15]



Entadamide B

Bioactivity

Photocytotoxic activity

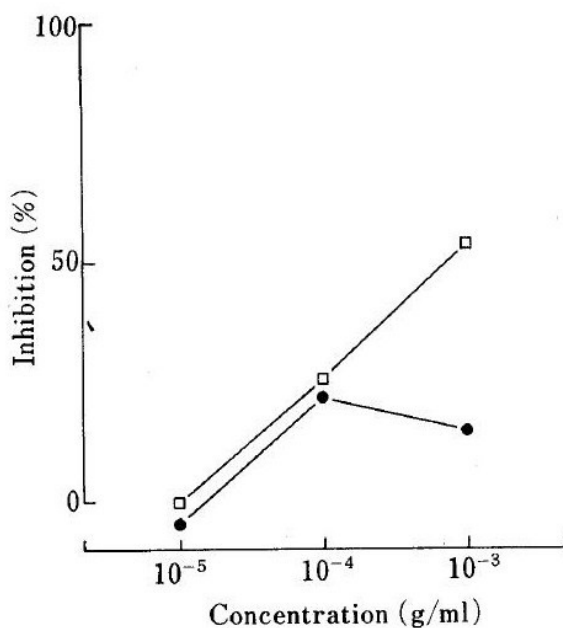
Photodynamic therapy means administering a tumorlocalizing photosensitizing agent followed by activating it by light of a specific wavelength which cause irreversible photodamage to tumour tissues [17].

Ong (2009) studied the *in vitro* photocytotoxic effect of several plants, including *E. phaseoloides*. Methanolic extracts of the stems was able to reduce the in vitro cell viability by more than 50% when exposed to 9.6 J/cm² of a broad spectrum light when tested at a concentration of 20 µg/mL. The methanolic extract of the leaves showed no activity [18].

Antiinflammatory activity

According to Ikegami (1989) entadamide A and entadamide B were investigated for inhibitory effect on the arachidonate 5- Lipxygenase of rat basophilic leukaemia cells. The results demonstrated that the entadamide B was significantly more effective than entadamide A, respectively. The researcher suggests these components may have potential to treat inflammatory diseases including bronchial asthma [16].

Figure 2: Effect of entadamide A (□) and entadamide B (●) on 5-lipoxygenase activities [16]



Molluscicidal activity

Yasuraoka (1977) studied molluscicidal activity of components in the bark of *Entada phaseoloides*. A butanol fraction of the methanol extracts of the bark showed high toxicity against *Oncomelania quadrasi* with the LC_{50} of 3.6 to 5.8 ppm. The researcher proved that the active molluscicidal agents contained at least two kinds of saponins, and its efficacy remained stable over a wide range of pH values, in the presence of minerals and yeast cells and after ultraviolet irradiation of solutions. Yasurakoda determined that doses higher than 40 g per square meter are necessary to produce molluscicidal effect under field conditions [19].

Side effects and toxicity

E. phaseoloides seeds are toxic. They have higher activity of trypsin and chymotrypsin inhibitor compared with soya bean, and a high level of saponins. A group of triterpenoid saponins in seeds have high haemolytic activity against cattle erythrocytes [7]. This may explain the use of these seeds as fish poison. Juice from the bark is been reported irritative to the eyes, causing conjunctivitis [3]. The tribal people in north-east India moisten the seeds and boil or roast them before eating. Moistening and removal of water is anticipated to remove saponins. The boiling or heating is a way to inactivate trypsin inhibitor ability [8] [9].

Table 5: Various antinutrients, toxicity and *in vitro* protein digestibility of *E. phaseoloides* seed kernels (g/kg DM) [7]

<i>Heat-stable antinutrients</i>	
Total phenolics	25.52 ± 1.31
Tannins	4.01 ± 0.21
Saponins	32.20 ± 2.40
Haemolytic unit activity of saponin extract (HeU) ^a	128.0
Phytic acid	13.67 ± 0.09
Raffinose	12.91 ± 0.03
Stachyose	24.97 ± 0.15
Verbascose	ND
<i>Heat-labile antinutrients</i>	
Hydrogen cyanide (mg kg ⁻¹ DM)	20.52 ± 0.81
Trypsin inhibitor activity ^b	96.65 ± 3.72
Chymotrypsin inhibitor activity ^c	30.02 ± 2.01
α-Amylase inhibitor activity	ND
<i>Phytohaemagglutinating activity (mg⁻¹ ml)^d</i>	
Against human O blood group	54.11 (0.02)
Against cattle erythrocytes	97.66 (0.01)
LD ₅₀ ^e	2.50 ± 0.10
<i>In vitro</i> protein digestibility (%)	67.03 ± 3.01

^a Haemolytic unit (HeU) mg⁻¹ extract.

^b mg pure trypsin inhibited g⁻¹ sample.

^c Chymotrypsin inhibitor unit mg⁻¹ sample.

^d Minimum amount of bean sample (mg) ml⁻¹ assay medium which showed haemagglutination; values in parentheses indicate HU mg⁻¹ sample; values are mean of triplicate determination ± standard deviation.

^e LD₅₀, 50% lethal dose; LD₅₀ represents the amount of saponin (mg) in 100ml of water producing death of 50% of tested fish under specified experimental conditions.

DM, dry matter basis.

ND, not detected.

Conclusion

E. phaseoloides seed kernel is a rich protein source which has a well-balanced amino acid composition. It has the certain macro and micro mineral elements and a high content of lipid with mainly unsaturated fatty acids. As regards the high digestible starch, high seed weight and number of seeds per pod, after inactivating of toxic components, it may be served a reasonable and cheap additional source of protein for economically indigent sections of the population. The plant is also well-known for its use in poison fishing. As entadamide B showed reasonably high inhibitory effect on the arachidonate 5- Lipxygenase, the plant may be a research candidate for an antiinflammatory product. Great care needs to be exercised in evaluating or acting on specific claims of therapeutic benefit from eating saponin type products.

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Pictures references

http://keys.trin.org.au:8080/key-server/data/0e0f0504-0103-430d-8004-060d07080d04/media/Html/taxon/Entada_phaseoloides.htm

6 *ACACIA PENNATA* WILLD.



Introduction

Family	<i>Leguminosae</i>
Butanical name	<i>Acacia pennata</i> Willd.
Burmese name	Subok-gyi, suyit
Parts of plant	Bark
Claimed med. Properties	In asthma and bronchites [15]

Young leaves of *Acacia pennata* which have a strong smell are an important food source in Thai. 100 g of fresh leaves contains: 57 kilocalories, 5.7 g fibre, 58 mg calcium, 4.1 mg iron, 80 mg phosphorus, 58 mg vitamin C, 0.05 mg vitamin B1, 0.24 mg vitamin B2, 1.5 mg Niacin and 10066 IU vitamin A.

In some countries *A. pennata* is also used as a medicine: Bark and fresh stem sap has been used as antiasthmatic and antibilious. Leaf has also been used as stomachic, styptic, and antibacterial. Boiled young leaves are used for fever, headache and body pain.

The smell from young leaves of *A. pennata* is so strong for myna (*Gracula religiosa*) birds that putting it near the myna cage possibly will kill the birds [1] [9] [16].

Synonym names

Searching in IPNI (international plant names index) gives 2 results:

- Leguminosae *Acacia pennata* Willd. -- Sp. Pl., ed. 4 [Willdenow] 4(2): 1090. 1806 [Apr 1806] (IK)
- Mimosaceae *Acacia pennata* (L.) Willd. -- Species Plantarum 4(2) 1806 (APNI)

It is explained the Mimosaceae is the Subfamily, and the family is Leguminosae [4].

In other languages:

English: Climbing Acacia, climbing wattle, feather acacia, narrow-leaved soap pod.

Hindi: Agla bel, Biswal.

Marathi: शेंबरटी shembarati, शेंबी shembi.

Tamil: இந்து inthu, காட்டிண்டு kattintu, காட்டுசிகை kattuchikai.

Malayalam: കാരീഞ്ഞ kaariinja, മല ഇഞ്ചു mala inja.

Telugu: గుబ కొరింద guba korinda.

Kannada: kaadu seege.

Oriya: gohira.

Konkani: सांबु sambu.

Sanskrit: अरि ari, खदिरवल्लरी khadiravallari, शिलीखदिर shilikhadira, ताम्रकण्टक tamrakantaka, वल्लिखदिर vallikhadira.

Nepali: अर्खु arkhu [3].

Results of searches in literature

Searching the name of ***Acacia pennata Willd*** in Google scholar resulted 640 results, meanwhile searching the name of ***Acacia pennata*** resulted 1020 results. And the same search plus ***medicinal*** resulted 303 results, 23 January 2011.

Search for "Any word= ***Acacia pennata***" in "Articles" in X-port found **11** results, and in Pub Med found 3 results, 23 January 2011.

28 references were found containing "***acacia pennata***" by searching in the SciFinder, 14 June 2010. It may show the popularity degree of the plant in researches.

Family of *Leguminosae* -The Pea Family

Legumes, the third largest flowering plant family, are an important ingredient of nearly all terrestrial biomes, on all continents (except *Antarctica*). The legume (or bean) family, which includes lentils, peas, beans, peanuts and soya, is important as a source of food because of its high protein content. These species range from dwarf herbs of arctic and alpine vegetation to massive trees of tropical forest. Many legumes are capable to fix atmospheric nitrogen in association with root bacteria or species of fungi. This tactics allows them to colonizing and growing in even the poorest soils, even as also helping to develop them.

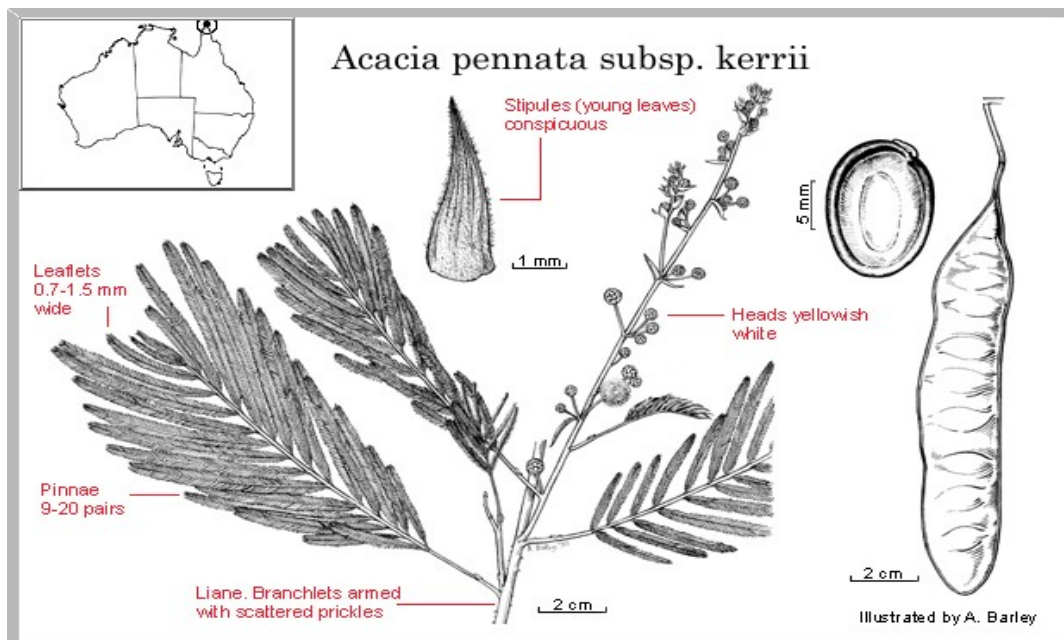
The main feature of the family is the fruit, a peapod which officially is known as a Legume. The Legume is adapted in many ways to make possible spreading by wind, animals and water.

According to F. Bisby, the family is divided into three subfamilies:

Papilionoideae, *Caesalpinioideae* and *Mimosoideae*. Sometimes these subfamilies are documented as three separate families. The three subfamilies are usually recognizable by their flowers. The *Mimosoideae* are mostly tropical or subtropical trees and shrubs characterized by their small, regular actinomorphic flowers which are. The stamens are maybe the most beautiful part of the flower, the five not immediately obvious petals. The leaves have double pinnate leaflets [5].

Morphologic description

Acacia pennata is an enduring climbing bush or a small tree. This thorny plant grows up to 5 meters tall. The stem is thorny. Young branches are covered with soft downy hairs, green and turn brown with age. A large gland appears on the main rachis of leaves above the middle of the petiole. Leaves are bipinnate, up to 50 pairs in each pinna, having tiny hair-like parts on the margins slackly set and overlapping. Flowers are in large terminal panicles, heads globe-shaped and pale yellow. The pods are flat, thin and long with thick sutures [1] [3].



Acacia pennata [2]

Branchlets have scattered prickles. Stipules of young leave covering flower buds are mostly ovate and tapering, to 0.9 cm long, notably in longitudinal direction veined, slightly hairy and a bit hooded. Leaves have petiole 2– 4 cm long, a flattened extended gland placed immediately or shortly above pulvinus. Rachis are 6– 22 cm long, with scattered prickles on lower surface, densely clothed with erect to patent hairs on upper surface, a flattened gland near junction of each of top 1– 3 pairs of pinnae. Pinnae have 9– 20 pairs; pinnules 25– 60 pairs in each pinna, diagonally linear-oblong, 3– 7 mm long, 0.7– 1.5 mm wide, sharp, glabrous or ciliate, with midrib excentric basally and nearly central above. Inflorescences capitate, axillary, racemose shape or paniculate shape arranged. Flowers are yellowish white. Calyx is glabrous (except apices of lobes). Pods oblong, 14– 16 cm long, 2.1– 2.6 cm wide, leather- like, dehiscent. Seeds are elliptic, 9– 11 mm long, 6– 8 mm wide, about 2 mm thick, brown. The plant grows mostly in north-eastern India, Burma, Cambodia, Laos, North and South Vietnam and the Lesser Sunda Islands (Sumbawa and Timor) [2].

Traditional medical use

In Burma, as Arnold Nordal noted, barks of *Acacia pennata* Willd. have been used in treatment of asthma and bronchitis. [15] In India, leaf juice mixed with milk is used for treatment of indigestion in infants, scalding of urine and curing bleeding gums. Some people use tender leaves for digestive complaints, cholera disease, relief of headache, body pain, snake bites, and even to cure fish poisoning. The root is used for inducing distension and to cure stomach pain. The bark is also used for stomach complaints [1] [3] [11] [16]. It is recommended that a root decoction of the some plants including *A. pennata* be used as a mouthwash for toothache or for steam inhalation. These plants are *Acacia pennata* Willd.; *Acacia ataxacantha* DC; *Balanites aegyptiaca* Del.; *Mimosa pigra* L.; *Diospyros mespiliformis* Hochst. ex A. DC.; *Ximenia americana* L.; *Fagara zanthoxyloides* Lam. , *Indigofera tinctoria* L.; *Acacia macrostachya* Reichenb. ex Benth. [10].

The paste made from bark is recommended to treatment of snakebite or scorpion sting, while the paste made from leaves is used as a haemostatic. In some countries the plant is eaten after some production as a choice food [12].

Phytochemistry & chemical structures

Bhumibhamon reports that 100 g of fresh leaves of *Acacia pennata* (AP) contains: 57 kilocalories, 5.7 g fibre, 58 mg calcium, 80 mg phosphorus, 4.1 mg iron, 10066 IU vitamin A, 0.05 mg vitamin B1, 0.24 mg vitamin B2, 1.5 mg Niacin and 58 mg vitamin C. According to Tapsoba (2006) the bark of contains tannin 9 %, lupeol and alpha spinasterol, and the stem contains sitosterol [1] [9]. Two terpenoids (**1** and **2**) and a flavonoid glycoside (**5**) is found and studied in AC leaves by Y. Rifai (2007): taepeenin D (**1**), (+)-drim-8-ene (**2**), and quercetin 3-*O*- β -d-glucopyranosyl-4-*O*- β -d-glucopyranoside (**5**) (Figure 1). Dongmo (2007) have isolated and studied two other flavonoids; quercetin 4'-*O*- α -L-rhamnopyranosyl-3-*O*- β -D-allopyranoside (**1**) and apigenin 6-*C*-[2''-*O*-(*E*)-feruloyl- β -D-glucopyranosyl]-8-*C*- β -glucopyranoside (**2**), beside isorhamnetin 3-*O*- α -L-rhamnopyranoside (**3**), kaempferol 3-*O*- α -L-rhamnopyranosyl-(1 \rightarrow 4)- β -D-glucopyranoside (**4**), and isovitexin (**5**) have isolated from the leaves of AP. (Figure 2) [6] [7].

Figure 1: (Rifai, Arai, Koyano, Kowithayakorn, & Ishibashi, 2010)

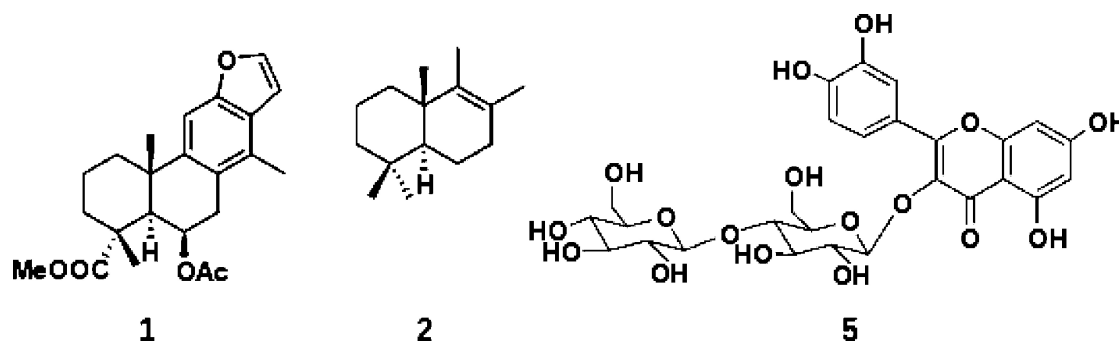
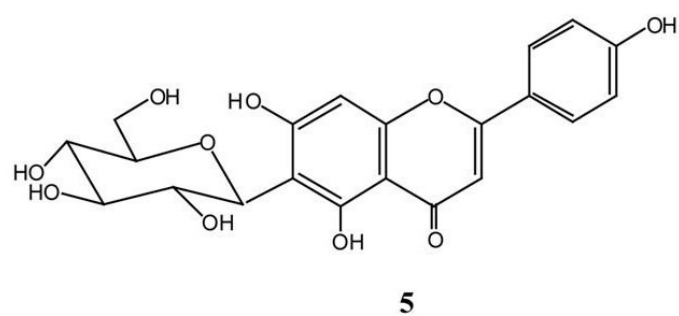
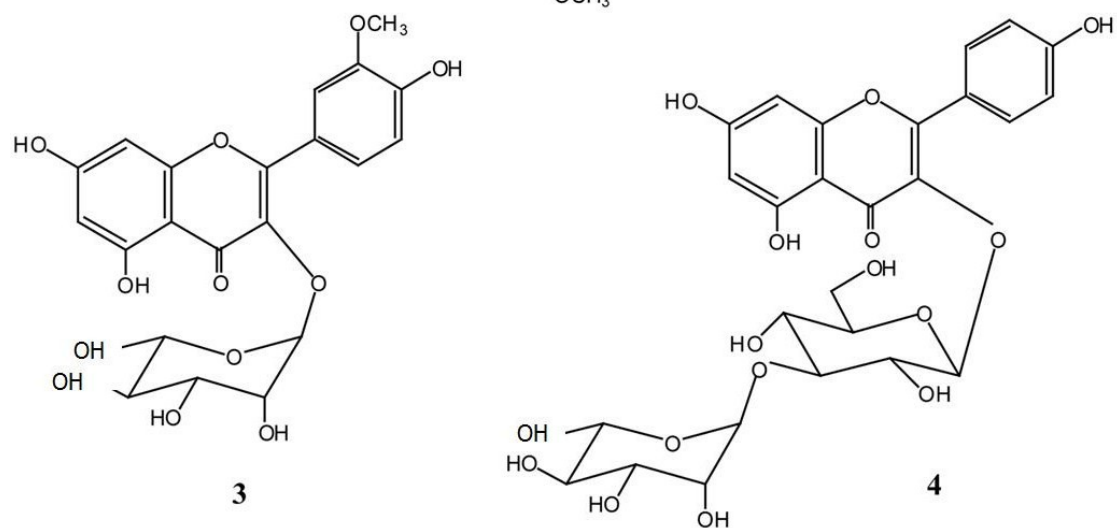
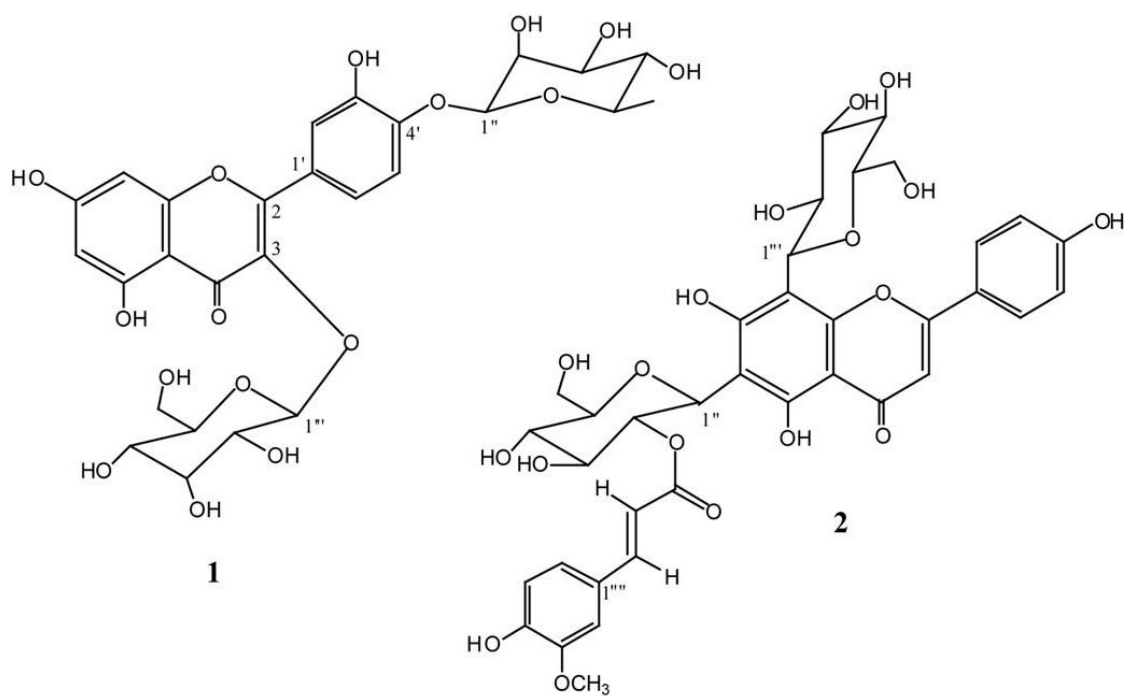


Figure 2: (Dongmo, Miyamoto, Yoshikawa, Arihara, & Lacaille-Dubois, 2007)



Bioactivity

Antiinflammatory and antinociceptive activity

Nociception (the neural processes of encoding noxious stimuli) is the afferent activity created in the peripheral and central nervous system by stimuli which may have the potential to damage tissue. This activity is launched by pain receptors (nociceptors).

In one study flavonoids of *Acacia pennata* (AP) included quercetin (1) apigenin (2), isorhamnetin (3), kaempferol (4), and isovitexin (5)(figure 2) was tested for analgesic and antiinflammatory activities. Material for this research was fine powdered leaves of AP which was extracted with ethyl acetate, chloromethane, hexane and methanol. The methanol residue was dissolved in water and divided with dichloromethane, hexane and water- saturated n-butanol. The researchers had confirmed their structures by 1D and 2D NMR and mass spectrometry. The Cyclooxygenase (COX-1 and COX-2) inhibitory activities of the mentioned compounds and the butanolic extract of AP were studied. Aspirin was used as positive control. The results are listed in (Table 1). The most effective COX-1 inhibitor appears to be the butanolic fraction. According to researchers, results showed 60 - 90 % inhibition at 10^{-4} g/mL and 5 - 14 % inhibition at 10^{-4} g/mL, correspondingly [7].

Table1: (Dongmo, Miyamoto, Yoshikawa, Arihara, & Lacaille-Dubois, 2007)

Inhibitory activities of **1-5** and the BuOH fraction of *Acacia pennata* against cyclooxygenases-1 (COX-1) and-2 (COX-2) :

Compounds	COX-1		COX-2	
	Inhibition (%)	IC ₅₀ (μg/mL) ^a	Inhibition (%)	IC ₅₀ (μg/mL) ^a
1	80.4	11.6	12.6	ND
2	NI	ND	8.6	ND
3	74.0	24.4	NI	ND
4	49.4	157.8	5.0	ND
5	66.4	30.6	7.4	ND
BuOH fraction	96.5	6.6	14.2	ND
Aspirin ^b	54.2	70.0	27.5	238

ND: not determined; inhibition (%) at 1×10^{-4} g/mL.

NI: no inhibition.

^a IC₅₀ based on duplicate four-point titration.

^b Commercial aspirin was used as positive control.

In another study the butanolic fraction of dried leaves of *Acacia pennata* was tested for analgesic and anti-inflammatory activities in animal models by Dongmo (2005). Paw formalin injection produces two distinct phases of pain-like behavior. The first phase starts right away after formalin injection (0–5 minutes), and the second phase begins in 10 min. Maximum response may occur 10–60 min after the formalin injection. Early phase of intensive pain, which starts directly after formalin injection, seems to be caused primarily by activation of C-fibres subsequent to peripheral stimulation. Then, within about 10 min nociceptive activity will reduced. The late phase of moderate pain begins about 20 min after formalin injection and continues about 40 min. This late phase appears to be caused by tissue and functional changes in the dorsal horn of the spinal cord. In this study, the butanolic fraction of AP was investigated and showed a considerable inhibition effect on the late phase. According to Dongmo, this may suggest the extract has NSAIDs-like efficacy, although there is some disagreements about COX-1 and COX-2 implicated in producing PGE2. The researchers concluded that AP exhibited a protective effect against chemical stimuli (acetic acid and formalin) and an inhibitory effect in carrageenin-induced rat paw edema in the late phase in the mouse. It also produced a major raise of the threshold of sensitivity to pressure-induced pain [8].

Hedgehog/GLI-mediated inhibitors

Hedgehog (Hh) signalling controls several events in embryonic development and adult tissue safeguarding. Scientists has described that over expression of glioma-associated oncogene 1 (GLI1) is a terminal effector and a target gene for Hh signalling route. It associates also with the progress of cancer. In one study Rifai (2010) implemented a cellular screen with taking advantage of a GLI-dependent luciferase reporter in human keratinocyte cells (HaCaT). They used two terpenoids (1 and 2) and a flavonoid glycoside (5) (*figure 1*) from *Acacia pennata* as Hh/GLI inhibitors. According to results the compounds 1, 2, and 5 exhibited selective cytotoxicity against human pancreatic and prostate (DU145) cancer cells, and have no toxicity on normal cells. They inhibit Hh signalling by down regulating of Ptch mRNA expression together with decreasing of protein level of PTCH and BCL-2. This result was coherent with a dose-dependent decrease of the protein levels of antiapoptotic BCL-2 and the tumour suppressor patched 1 protein. The researchers suggested the compound has an inhibitory effect on the transcription of Hh/GLI and may have potential to be used in Hh/GLI-dependent cancer [6].

Antifungal activity

Malabadi (2007) studied antifungal activity in some plants including *Acacia pennata*. The plants material was extracted with four unlike solvents: acetone, hexane, Dichloromethane (DCM) and methanol. After evaporation of extracting solvents, the hexane, dichloromethane and methanol extracts were dissolved in acetone because this solvent is not to be destructive to bacteria. The researchers settled Minimum Inhibitory Concentration (MIC) values by checking growth after 24 and 48 hours to find the end point. The MIC values of most of the AP's extracts were about 0.02 to 0.68 (*Table 2*). The acetone extracts of *Acacia pennata* showed a notable antifungal effect against *Aspergillus fumigatus*. The methanol extract of *Acacia pennata* was significantly active against all the tested pathogens with the MIC values ranging from 0.02 to 0.05. The rest of the extracts showed moderate antifungal activity towards all the tested organisms. (*Table 2*) [14].

Table 2: MIC values of *Acacia pennata* after 24 and 48 hours incubation. (Malabadi, Kumar, 2007)

Table 1: MIC values in mg mL⁻¹ of *Acacia pennata* plant species after 24 and 48 h incubation

Organisms	Time (h)	MIC values (mg mL ⁻¹)			
		Acetone	Hexane	DCM	Methanol
<i>C. albicans</i>	24	0.18	0.67	0.27	0.02
	48	0.18	0.68	0.27	0.02
<i>K. polysporus</i>	24	0.15	0.31	0.09	0.03
	48	0.15	0.30	0.10	0.06
<i>A. niger</i>	24	0.42	0.19	0.17	0.03
	48	0.41	0.21	0.17	0.03
<i>A. fumigatus</i>	24	0.04	0.24	0.04	0.05
	48	0.04	0.24	0.04	0.05

Antioxidant activity

There are studies using the β -carotene bleaching method that suggest *Acacia pennata* has a considerable antioxidant effect better than 25 mg BHA equivalent/100 g fresh weight [17] [18] [19]. Although there are other researches which show a moderate to mild antioxidant effect of *Acacia pennata* [20].

Side effects and toxicity

There are many indigenous sources of botanical fish toxicants that are toxic to a wide range of animals including fish; one of these plants is *Acacia pennata*. According to Weiss (1973) the use of *Acacia pennata* is common among fish farmers in controlling pests and predators [21]. Udolisa (1986) says the active component is the tannin from the stem and bark which influences the respiratory organs of fish [22] [23]. The on purposeal adding of such plants in the water ecosystems may lead to physiological tension in aquatic life forms and eventually decrease in aquatic productions.

Young leaves of *Acacia pennata*, though having a strong smell, are an important food source for Thai people. In Thai they eat raw or fast-boiled leaves (always with '*samba*'). Samba is a mixture of garlic, chili, salt, lemon juice, shrimp and shrimp paste. They also use leaves as a vegetable in several hot spicy foods. *Kaeng Kae*, a northern Thai curry, will not be accepted without *Acacia pennata* leaves. That means leaves have been accepted as a non-toxic and safe plant to human [1] [13].

Conclusion

Acacia pennata is an important food source for Thai people. The smell from young leaves of the plant is strong. It is also used as a traditional medicine in India and some other parts of the world. Leaf juice mixed with milk is used for treatment of indigestion in infants. It is also used for scalding of urine and for curing bleeding gums. Some people use boiled tender leaves for cholera treatment, digestive complaints, relief of headache, body pain, snake bites, and even to cure fish poisoning. The root can be used for inducing flatulency and to cure stomach pain. The bark is used for treatment of bronchitis, asthma and for stomach complaints.

There have been few scientific studies of the plant. Most studies have been on antiinflammatory, antioxidant, antinociceptive and inhibitory effect on the transcription of Hh/GLI. It has showed also a great Antifungal activity. The antiinflammatory effect of the plant which has proved can be a basement for treatment of asthma by use of *Acacia pennata*, although more clinical studies is been needed.

Since the antifungal drugs are mostly expensive, or have notable side effects, *Acacia pennata* can also be a potential source to produce a new antifungal medicine.

Although the whole plant is used to kill the fish, no significant toxicity has reported about this plant. Since it is eaten often as a vegetable, it seems to be a safe source for further clinical studies. More studies are needed and possible mechanisms should be mapped before the plant can be used as potential drugs in the future.

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Dinesh Valke's photoalbum:

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7 *PITHECELLOBIUM DULCE* BENTH.



Introduction

Family	<i>Leguminosae</i>
Butanical name	<i>Pithecellobium dulce</i> Benth.
Burmese name	Kala-magyi
Parts of plant	Leaves
Claimed medicinal Properties	Abortive, digestive [1].

Pithecellobium dulce is found growing in many unattended waste districts. The plant is said to have originated in Central America, but it has also been naturalized all the way through South-east Asia, especially in Thailand, Indonesia, Malaysia, India and the Philippines. *P. dulce* can survive unfavourable climates. It is a tree with many uses; food (sweet pods), firewood, honey, fodder, soap oil, tannin, hedges and shade. The generic name refers to the curly pod, that mimics an ape's earring (*pithekos ellobium*), and the species name "*dulce*" refers to the sweet pod [24]. (Figure 1)



Figure 1: *P. dulce* (From Little and Wadsworth- 1964)

Synonym names

Searching whole name *Pithecellobium dulce* in all records in **IPNI** (international plant names index) gives **2** results:

- Leguminosae *Pithecellobium dulce* Benth. -- London J. Bot. 3: 199. 1844 (IK)
- Mimosaceae *Pithecellobium dulce* (Roxb.) Benth. -- London J. Bot. 3: 199. 1844 (GCI)

Synonyms according to *The plant list*:

Acacia obliquifolia M.Martens & Galeotti, *Albizia dulcis* (Roxb.) F.Muell., *Feuilleea dulcis* (Roxb.) Kuntze, *Inga camatchili* Perr., *Inga dulcis* Mart., *Inga dulcis* (Roxb.) Willd., *Inga javana* DC., *Inga javanica* DC., *Inga lanceolata* "sensu Blanco, non Kuntze", *Inga leucantha* C.Presl, *Inga pungens* Willd., *Mimosa dulcis* Roxb., *Mimosa edulis* Gagnep., *Mimosa pungens* (Willd.) Poir., *Mimosa unguis-cati* Blanco, *Pithecellobium littorale* Record, *Pithecollobium dulce* (Roxb.) Benth., *Zygia dulcis* (Roxb.) Lyons [2].

Results of searches in literature

Searching the name of ***Pithecellobium dulce* Benth.** in Google scholar resulted 762 results, meanwhile the same search plus ***medicinal*** resulted 206 results. Searching the name ***Pithecellobium dulce* Benth.** in SciFinder (after removing duplicates) resulted 14 results (without *Benth.* resulted 110). Searching in Pub Med found no result (without *Benth.* Resulted 8), and in the ISI WEB OF KNOWLEDGS resulted 7 results, 29 January 2011.

Family of *Leguminosae*

Legumes, the third largest flowering plant family, are an important ingredient of nearly all terrestrial biomes, on all continents (except *Antarctica*). The legume (or bean) family, which includes lentils, peas, beans, peanuts and soya, is important as a source of food because of its high protein content. These species range from dwarf herbs of arctic and alpine vegetation to massive trees of tropical forest. Many legumes are capable to fix atmospheric nitrogen in association with root bacteria or species of fungi. This strategy allows them to colonizing and growing in even the poorest soils, even as also helping to develop them. The main feature of the family is the fruit, a peapod which officially is known as a Legume. The Legume is adapted in many ways to make possible spreading by wind, animals and water. The family is

divided into three subfamilies: *Papilionoideae*, *Caesalpinioideae* and *Mimosoideae*. Sometimes these subfamilies are documented as three separate families [3].

Morphologic description

Pithecellobium dulce is a small to medium-sized and spiny shrub or tree up to 18 m height. It is broad-spreading with irregular branches. The bark is grey, becoming rough, furrowed and then peeling. Branchlets are brown, rounded and sparsely puberulous. They have also spinescent stipules. Leaves are bipinnate with a gland at the junction of the leaflets, and leaflets oblong to 4 cm in length. The spines are in pairs at the base of leaves, and range from 2 to 15 mm in length. The flowers are in small white heads. Each flower has a hairy corolla and calyx surrounding about 50 thin stamens united in a tube at the base. Flowering begins in 3-4 years and is seasonal and the fruits ripen from April to July. Pods are dark-brown outside, reddish to pinkish within, slightly flattened, glabrous or puberulous, 10-12.5 x 1-1.6 cm, and become spiral as they mature. Seeds are about 10 per pod, black and shiny, obovate to oblong, often asymmetric in outline, flattened, 9-12 x 7-8 x 1-2 mm, hanging on a reddish thread from the pod [4] [5].

Traditional medicinal use

Leaves are used as a plaster to allay pain, and can relieve convulsions. The leaves with salt are named as a cure to indigestion and induce abortion. Insulin-like principle has been reported in the leaves. The aril is reported to be used in preparing a drink similar to lemonade in Mexico. The salty extract of the seeds showed a haemolytic agglutinating reaction with human blood. The bark of the root is used for dysentery, and as a febrifuge in Guiana. The decoction is given as an enema. The plant is reported to be a folk remedy for earache, leprosy, peptic ulcer and toothache. In folk medicine it is also used as emollient, soothing and larvicide. Infusions of different parts have been used traditionally to treat diseases, such as skin of the stem for dysentery, leaves for intestinal disorders, and seeds for ulcer [6] [7] [8] [9] [10].

Phytochemistry and chemical structures

According to Nigam Shyam (1971) the seed contains 13.5% moisture, 17.6% protein, 17.1% crude fat, 7.8% crude fibres, 41.4% starch and 2.6% ash. The aril contains moisture 77.9; protein 0.7; fat, 0.6; fibre 1.2; carbohydrates 19.9; and mineral matter, 0.7%; calcium, 13.0mg.; phosphorus 54.0 mg. ; iron, 1.4mg.; thiamine, 222 µg; riboflavin, 59 µg.; nicotinic acid, 0.36mg.; and ascorbic acid, 120 mg per 100gm. Further the essential amino acids in the aril were reported: valine, 143; lysine 178; phenylalanine, 41; and tryptophan, 26 mg per 100g. The leaves contain 29.0% crude protein, 17.5% crude fibre and 5.6 % ash [11].

The following table (*Table 1*) shows the most important compounds found in different parts of the plant: [12] [13] [14] [15] [16]

Name	Part of the plant
Pitheduloside A	Seed
Pitheduloside B	Seed
Pitheduloside C	Seed
Pitheduloside D	Seed
Pitheduloside E	Seed
Pitheduloside F	Seed
Pitheduloside G	Seed
Pitheduloside H	Seed
Pitheduloside I	Seed
Pitheduloside J	Seed
Pitheduloside K	Seed
Dulcin	Seed
Saponin P _E	Seed
Oleanolic acid	Seed
Echinocystic acid	Seed
Pithecelloside	Seed
Glucoside of – b sitosterol	fruit pulp
Campesterol	fruit pulp
Stigmasterol	fruit pulp
Dulcitol	Leaves
β-sitosterol	Heartwood
Genistein 4'-o-α-L-rhamnoside	Root
Quercetin	Leaves & Seed
Kaempferol	Leaves & Seed
Kaempferol-3-rhamnoside	Leaves
α-spinasterol	Leaves
β-D glucoside of a-spinasterol	Leaves
Octacosanol	Leaves

Table 1: The most important compounds of *P. dulce* extracts

Kulkarni (1992) studied the fatty acids distribution in total lipids, phospholipids and glycolipids of *P. dulce* seeds. Palmitic, stearic, oleic, linoleic, myristic, linolenic and arachidic acids were the main fatty acids [25]. Saxena (1999) studied the stem of the plant and reported a flavonoid, 3'-prenyl apigenine -7-O- rutinoside [26]. The alcoholic extract of the leaves has already been studied by Nigam (1970). The researcher reported octacosanol, β -D-glucoside of α -spinasterol, α -spinasterol and kaempferol-3-rhamnoside [27]. The sterol glucoside-A from the fruit pulp reported by Nigam (1968), was a mixture of glucoside of β -sitosterol, campesterol and stigmasterol [28]. Kaempferol-3-O- α -L-rhamnopyranoside, lutein β -carotene, spinasterol, dodecaprenol, and tridecaprenol were also isolated from *P. dulce* [17]. High tannin content (12-35%) was also already found in barks of the plant by Baens (1934) [18]. Isoquercetrin, the flavonol glycoside quercetin 3-O-glucoside along with kaempferol from the leaves of the plant was isolated by Saxena (1998) [20].

Bioactivity

Abortion inducing activity

According to Banarjee (2005) the isoflavonoid isolated from root extract showed dose dependent oestrogenic activity by increasing uteri weight from 15.5 mg in control to 34.2 mg in orally treated female rats [29].

Anti inflammatory activity

Bhargva Krishna (1970) studied the saponins earned from fruits of *P. dulce* against the exudative and proliferative phase of inflammatory reaction in albino rats by using carrageenin induced oedema and formaldehyde induced arthritis models. Results showed the ED₅₀ (mg/kg) of the saponin was found to be 10.0 in comparison to hydrocortisone (9.8) which was used as the reference standard [30]. Some other studies showed moderate [31] [32] to notable antiinflammatory effect [33].

Antivenom activity

Polyphenols from the watery extract of *P. dulce* was tested for inhibitory activities against Naja kaouthia (NK) venom by *in vitro* neutralization method. According to Pithayanukul (2005) the extract inhibited the lethality of the venom and the venom necrotizing activity at the minimum necrotizing dose. The researcher reported also the extract inhibited 90% of the acetylcholinesterase activity of NK venom at lower tannin concentration. It was suggested the antivenom activity of this plant induces selectively by blocking the nicotinic acetylcholine receptor, and non-selectively by precipitation of the venom proteins [34].

Protease inhibition activity

Kunitz STI protease inhibitor is a protein which acts as a protease inhibitor. Kunitz-type soybean trypsin inhibitors are usually specific for either trypsin or chymotrypsin. They are thought to protect seeds against consumption by animal predators. Delgado (2004) reported isolating a protease inhibitor from the seeds of *P. dulce*. The trypsin inhibitor was a protein comprised of two polypeptide chains joined by disulfide bridges. PDTI showed no chymotrypsin inhibitory activity [35].

Antibacterial and antifungal activity

Watery and methanolic extracts of *P. dulce* seeds showed fungicidal and fungistatic effects against plant pathogens such as *Rhizopus stolonifer*, *Botrytis cinerea*, *Penicillium digitatum* and *Fusarium oxysporum*. Presence of two triacyl glycerols, glycerol 1,3-dilinoleoyl-2-decanoic, glycerol 1-linoleoyl-2- docosanoic-3- olein is proved in the extracts by the researchers. Other studies proved *in vitro* inhibitory effect of triterpene saponins, pitheduloside A, B, E, F and I on mycelial growth of *colletotrichum gloeosporioides*, *Rhizopus stolonifer* and *Rhizoctonia solani* [36] [37]. According to Ali (2001) the highest growth inhibition was observed with the hexane extract of *P. dulce*, while the extract showed low activity against *Microsporum canis* [22].

Moreno Salazar (2008) examined the methanol extracts antibacterial activity against the four enterobacteria: *Shigella flexneri*, *Salmonella typhimorium*, enteropathogenic *Escherichia coli* (ATCC 35218) and *Escherichia coli* (ATCC 25922). The extract showed activity against all evaluated enteropathogenic bacteria [21]. Ragasa (2005) reported isolation of 1,2- and 1,3-diacetyl glycerol and Kaempferol-3-O- α -L-rhamnopyranoside, lutein β -carotene, spinasterol, dodecaprenol, and tridecaprenol from *P. dulce*. The researcher studied the antibacterial and antifungal effects of these components. According to results the diacetyl glycerols possess high antifungal activity against *Aspergillus niger*, moderate activity against *Pseudomonas aeruginosa* and *Candida albicans* and slight activity against *Bacillus subtilis*, *Escherichia coli*, and *Trichophyton mentagrophytes*. Results showed also that it had no effect against *Staphylococcus aureus*. Besides Kaempferol-3-O- α -L-rhamnopyranoside had a moderate effect against the fungus, *C. albicans*, and slight effect against the fungi *A. niger*, *T. mentagrophytes*, and the bacteria *E. coli* and *P. aeruginosa*. It showed no effect against the bacteria, *S. aureus* and *B. subtilis* [17]. Saxena (1998) had already reported isolation of the flavonol glycoside quercetin 3-O-glucoside (isoquercetrin) and kaempferol from the leaves of the plant. Studying the leaf extract by the researcher showed encouraging antibacterial and antifungal efficacies [20]. Shanmugakumar (2005) and (2010) studied the hexane, chloroform and alcoholic extracts of the leaves for their antibacteriac activity by BACTEC460TB-Radiospirometric system. He reports the alcoholic extract at the concentration 20mg/ml showed highest activity [38] [39].

Antidiabetic activity

Alpha-glucosidase inhibitors are used as antidiabetic drugs. The known mechanism is preventing digesting carbohydrates. Carbohydrates are in general converted into monosaccharides, and α -glucosidase inhibitors reduce the impact of carbohydrates on blood sugar [Wikipedia]. The α -glucosidase inhibitory activity of some plant was studied by Tunsaringkarn (2008). Leaves and stem barks of *p. dulce* were extracted using soxhlet apparatus with petroleum ether, dichloromethane and ethanol. The water-soluble part of extract showed mild (stem barks) to no (leaves) α -glucosidase inhibitory activity [19].

Hepatoprotective activity

Manna (2010) studied watery extract of the fruits of *P. dulce* effect against carbon tetrachloride (CCl_4)-induced hepatic injury using Swiss albino mice. According to qualitative analysis, flavonoids, saponins, phenolics and steroids existence in the fruit extract was proved. It is known that CCl_4 administration causes hepatic cell death mainly via the necrotic pathway. Treatment with the extract protected the organ from CCl_4 -induced hepatic damage. (Figure 2) Manna reported the effect was dose-dependent and time-dependent [23].

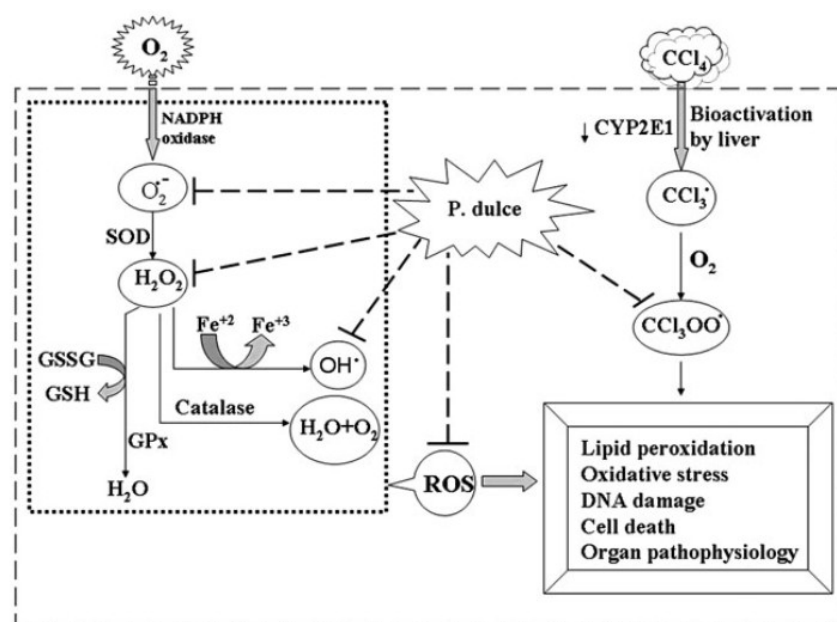


Figure 2: Schematic diagram of the antioxidative and protective role against CCl_4 -induced hepatic pathophysiology [23]

H⁺, K⁺-ATPase inhibition activities

Megala (2010) studied the free radical-scavenging trait and the inhibitory effect on H⁺, K⁺-ATPase activity of watery and hydroalcoholic fruit extracts of *P. dulce*. The hydroalcoholic fruit extracts showed the significant free radical-scavenging activity in all the experimental models. On the other hand, it showed H⁺, K⁺-ATPase inhibitory activity. According to Megala, since the hydroalcoholic fruit extracts possess a good antioxidant ability, it can be studied for antiulcer activity [40].

Clinical studies and therapeutic activities

No clinical study has been found about *Pithecellobium dulce* so far.

Side effects and toxicity

Toxic effects of powders of *P. dulce* seeds and leaves on larvae of fall armyworm (*Spodoptera frugiperda*) were reported before by Bautista (2003) [36]. Antibacterial, fungicidal and fungistatic effects of the different parts of the plant have also widely studied [21] [22] [36] [37]. But no direct scientific study was found about toxicity or side effects of use of the plant so far.

Conclusion

Although the existing chemical and pharmacological studies on the plant are quite remarkable, it seems to be needed more clinical studies to prove effectiveness and harmlessness of *Pithecellobium dulce* to human.

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8 *PITHECELLOBIUM LOBATUM* BENTH.



Introduction

Family	<i>Leguminosae</i>
Butanical name	<i>Pithecellobium lobatum</i> Benth.
Burmese name	Tanyin, Danyin
Parts of plant	Seeds
Claimed medicinal Properties	In diabetes [1].

Pithecellobium lobatum commonly is a species of flowering tree in *leguminosae*. It is native to South-east Asia and grows in rainforest, altitude 0 to 1200 m. In Indonesia, Malaysia, Myanmar and Thailand its large brown legumes are popular food. The beans are mildly toxic [6].

Synonym names

According to **The Plant List** the name **Pithecellobium lobatum** has been misapplied or erroneously used to refer to 4 plants: *Archidendron bubalinum* (Jack) I.C.Nielsen; *Archidendron havilandii* (Ridl.) I.C.Nielsen; *Archidendron pauciflorum* [var. pauciflorum \(Benth.\) I.C.Nielsen](#) and *Archidendron scutiferum* [\(Blanco\) I.C.Nielsen](#).

The only acceptable synonym name is *Archidendron falcatum* I.C.Nielsen [16].

Searching the name **Pithecellobium lobatum** in **IPNI** (international plant names index) gives 1 result:

- Leguminosae *Pithecellobium lobatum* Benth. -- London J. Bot. iii. (1844) 208. (IK)

Searching the synonym name **Archidendron falcatum** in **IPNI** gives also 1 result:

- Leguminosae *Archidendron falcatum* I.C.Nielsen -- Opera Bot. 76: 44 (1984 publ. 1985). (IK)

Other common names: Tanyin, Danyin [1], Danyin-Wek (Burmese), Ngpi Nut (English), Jengkol (French), Jengkol (Indonesia), Jering, Jiring (Malay) and Dhinyindi (Nepalese) [5].

Results of searches in literature

Searching the name of **Pithecellobium lobatum** in Google scholar resulted 72 results, meanwhile the same search plus **medicinal** resulted 39 results, 30 January 2011. Searching the name in Pub Med resulted in no result, in the ISI WEB OF KNOWLEDGS resulted 1 result and in SciFinder (after removing duplicates) resulted 42 results, 28 January 2011. Searching the synonym name **Archidendron falcatum** in Google scholar resulted 21 results (none was relevant), while in Pub Med and ISI no match

found. Searching the name * ***Archidendron pauciflorum*** * in SciFinder (after removing duplicates) resulted 38 results and in ISI resulted none, 29 January 2011.

Family of *Leguminosae*

Legumes, the third largest flowering plant family, are an important ingredient of nearly all terrestrial biomes, on all continents (except *Antarctica*). The legume (or bean) family, which includes lentils, peas, beans, peanuts and soya, is important as a source of food because of its high protein content. These species range from dwarf herbs of arctic and alpine vegetation to massive trees of tropical forest. Many legumes are capable to fix atmospheric nitrogen in association with root bacteria or species of fungi. This tactics allows them to colonizing and growing in even the poorest soils, even as also helping to develop them. The main feature of the family is the fruit, a peapod which officially is known as a Legume. The Legume is adapted in many ways to make possible spreading by wind, animals and water. The family is divided into three subfamilies: *Papilionoideae*, *Caesalpinioideae* and *Mimosoideae*. Sometimes these subfamilies are documented as three separate families [13].

Morphologic description

The tree is to 20 meters high and up to 22 cm in diameter. Branchlets are terete or a little angular in the final parts, greyish, scarcely slightly hairy, glabrescent, or glabrous. Petiole is 0.5 to 3.5 cm, usually with 2 glands, broadly elliptic to round, flat, 1-3 mm in diameter. Pinnae have 1 (or 2) pairs, 3 to 10 (13.3) cm, with round glands, flat, 0.5-1 mm in diameter. Leaflets have 2 to 4 pairs per pinna, opposite or the proximal pair subopposite, papery, apex acuminate to subcaudate. Both surfaces are glabrous. Inflorescences are either clustered at the old leaf-scars or terminal, scarcely puberulous or glabrous, consisting of pedunculate glomerules aggregated into panicles. Pod is about 10 cm long, 0.7 to 1.5 cm wide across the seeds. Seeds are about 8 to 9 X 6-8 X 4 mm [6].

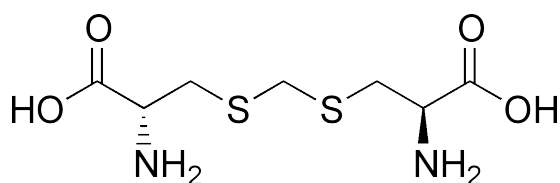
Traditional medicinal use

Leaves and barks of *Pithecellobium lobatum* are crushed and applied in chest pains, pains and skin problems. Ashes acquired by burning the old leaves are applied on itch, and ashes acquired by burning the young leaves are applied on cuts, wounds. Fruits are eaten to treat diabetes and hypertension [1] [15] (Not so trustable).

Phytochemistry and chemical structures

The protein content and amino acid and biochemistry compounds of seeds of *Pithecellobium lobatum* have been studied by Gwan (1968), Felker (1977) and Shanker (1993). Gwan (1968) had already reported that each 100 g protein isolated from the beans contained aspartate 9.4 g, glutamate 8.8 g, serine 5.8 g, glycine 7.7 g, threonine 3.6 g, alanine 8.2 g, histidine 3.3 g, lysine 5.3 g, arginine 9.0 g, proline 15.8 g, valine 4.4 g and leucine 4.2 g. He could not find any cysteine, cystine, or phenylalanine. He reported also that Methylenecyclopropyl amino acids which have been shown to be hypoglycemic constituents of other fruits were not found in *Pithecellobium lobatum* bean. The core of the protein was 0.79 compared to 0.58 and 0.47 for casein and soy protein respectively [8] [9] [10]. Five flavan-3-ol derivatives including flavan-3-ol gallates, galocatechin 3'- and 4'-O-gallates and galocatechin 7,3'- and 7,4'-di-O-gallates have been isolated from a watery acetone extract of the dried leaves by Lee (1992). Studying watery acetone extract of the pods showed three proanthocyanidins including procyanidins B-3, B-4 and prodelphinidin B-1 and galocatechin [7]. The bean contains 1-2% djenkolic acid (*S,S*-methylenebiscysteine) [11] [12]. (Figure 1)

Figure 1: Djenkolic acid



Bioactivity

No scientific study has been found about *Pithecellobium lobatum* bioactivity so far.

Clinical studies and therapeutic activities

No clinical study has been found about *Pithecellobium lobatum* so far.

Side effects and toxicity

Kidney stones, acute kidney injury and tubular necrosis can result from high urinary concentrations of metabolites of *Pithecellobium lobatum* [14]. Djenkolic acid (*S,S*-methylenebiscysteine) has got its name from common name of the plant, djenkol bean. The bean contains 1 to 2% djenkolic acid [11]. According to Bell (2003) eating it crudely can cause acute kidney malfunction and impaired urine flow. The toxic effects are reported to be result from the low solubility of the amino acid which leads to forming crystals [12].

Conclusion

Legumes of *Pithecellobium lobatum* are a popular food in Indonesia, Malaysia, Myanmar and Thailand. The beans are mildly toxic. Due to this there have not been found some clinical or biological studies that can describe biological features of the plant, it is needed further scientific researches to decide about the medicinal capacities of the plant.

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Garden flowers of Malaysia

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9 *ALBIZIA LEBBECK* BENTH.



Introduction

Family	<i>Leguminosae</i>
Butanical name	<i>Albizzia lebbek</i>
Parts of plant	Leaves, bark
Claimed medicinal Properties	In ophtalmia (leaves), in dysentery (bark) [1]

Albizzia lebbek is a reasonably important plant for both industrial and medicinal uses. The leaves are good fodder which has high content of protein ingredients. The seeds contain 43.6% protein compared to soybean with 42.8%. It is grown as fodder for camels, water buffalo and cattle in India and some other countries [10] [24]. In apiculture its flowers are aromatic and so catch the attention of bees. It is highly concerned by them who keep honey bees to securing commodities for the light-coloured honey as a source of nectar and pollen [18]. *A. lebbek* is also recognized as a nitrogen-fixing tree, quality hardwood for furniture, veneer, turnery, general construction, carts, carving, firewood, and charcoal. An extract from the bark is used as tannin. The tree can be planted for shade, erosion control and as an ornamental. In India it is commonly found as a cover crop in tea and coffee plantations. Leaves can be also used as green manure [7]. The root shape makes *A. lebbek* a good soil binder and took to soil conservation and erosion management. It is also used as a decorative and tree. The tree is been planted for shade as a cover crop in tea and coffee plantations. Different parts of the tree are used in folk cures for many illnesses. The bark is been used for making soap and in tanning [2] [3] [4] [5].

Synonym names

Searching in IPNI (international plant names index) gives 2 results: (no result for searching the name **Albizzia**)

- ☐ Leguminosae *Albizzia lebbek* Benth. -- London J. Bot. 3: 87. 1844 (IK)
- ☐ Mimosaceae *Albizzia lebbek* (L.) Benth. -- Hooker's London Journal of Botany 3 1844 (APNI)

In other languages:

Africa (Swahili): mkingu, mkungu

Arabic: daqn el-Basha, dign el basha, labakh, laebach, lebbek

Brazil: ébano-oriental, coração-de-negro, língua-de-mulher, língua-de-sogra

Burma: kokko

Cambodia: chreh

Carolines: schepil kalaskas

Cook Islands: 'arapitia

English: woman's tongue tree, east Indian walnut, frywood, Indian siris, koko, lebbek, lebbeck, lebbektree, rain tree, raom tree, rattlepod, siris tree, soros tree, Tibet tree

Ethiopia: lebbek

Fiji: vaivai ni vavalagi

French: bois noir, bois savane, ebénier d'Orient, tcha tcha (Creole)

German: lebachbaum, Andamanen-kokko

Hawaii: white monkeypod

India: bage, begemara, bengha, beymada, bhandir, diriina, chinchola, darshana, dieng-salvrin, dirasan, dirasanam, dirisana, doddabagi, gachoda, garso, goddahunse, harrerri, hirih, kalbaghi, kalshish, karuvagei, katu vagai, katvaghe, kinhi, kokko, kona, kothia koroi, lasrin, mathirsi, moroi, munipriva, nenmenivaka, salaunjal, samkesar sirisha, sarin, sarshio, seleyadamara sirsul, shrin, shirson, shirish, sirai, sirar, siras, sirin, siris, sirish, sirisah, tantia, tinia, vaga, vagai, vagei, vaka, vakai, vellavaka, velvgai, voghe

Indonesia: tekik, kitoke, tarisi

Italian: albizia indiana

Lao: ka `sê (Sino-Tibetan), mai thone

Latin America: bano-oriental, lengua de mujer

Lesser Antilles: vieille fille, shack-shack

Madagascar: bonara, bwar nwar; fany; faux mendoravina

Malaysia: batai, batai batu, kungkur, oriang

Marianas Islands: kalaskas, mamis, trongkon kalaskas, trongkon-mames, tronkon mames

Mexico: canjuro

Nepal: kalo siris

Panama: mata-raton

Philippines: aninapala, langil

Seychelles: boir noir; bois noir

South Africa: lebbekboom

Spanish: acacia chachá, algarroba de olor, amor plantónico, Aroma, aroma fracesca, cabellos de ángel, faurestina, florestina, lengua de mujer, lengua viperina

Sri Lanka: kona, vageri, mara, vakai siridam, suriya mara

Thailand: chamchuri, kampu, ka se, khago, cha kham, chamchuri, kampu, phruek, suek

Venezuela: acacia; baile de caballero

Vietnam: bô kê tây, lim xanh, trât

Yap: gumorningabchey, ngumormingobchey [2][6].

Results of searches in literature

Searching the name of *Albizia lebbek* in Google scholar resulted **1830** results, and the same search plus *medicinal* resulted 892 results, July 2010. Search for "**Any word= (*Albizia lebbek*)** and **Any word= (medicinal)**" in "Articles" in X-port found **6** results, July 2010. Searching the name of the plant gave just **8** results in Pub-med (July 2010), meanwhile the ISI-WEB OF KNOWLEDGE resulted **32** results. It may explain the popularity of the plant in researches.

Family of Leguminosae

Fabaceae or *Leguminosae* is a large and economically significant family of flowering plants, which is usually known as the legume family, pea family, bean family or pulse family. The word '*Fabaceae*' comes from the defunct genus *Faba*. *Leguminosae* (the older name) is also still valid and refers to the typical fruit of these plants which are called legumes. *Fabaceae* is the third major family of flowering plants, according to the Royal Botanical Gardens. The largest genera are *Astragalus*, *Acacia* and *Indigofera* [6].

Morphologic description

A. lebbbeck is a deciduous and semi deciduous tree up to 6 to 12 meters high (may also reach to 30 m in native forests), the trunk may grow up to 1-2 m. Monsoon forests and rainforests are its native habitat. It is native to: Pakistan, India, Bangladesh, the Andaman Islands, Burma, S China, Thailand, Malaysia, Sri Lanka, the eastern islands of Indonesia, Africa and north Australia [2] [7]. In open locations *A. lebbbeck* develops as a spreading and sometimes multistemmed tree, to 25 m tall and 30 m across with little branching. Bark is grey, rough, and a little flaky; inside reddish. Stems are green, terete, spotted, covered with soft downy hairs when young, and quickly becoming grey brown. Leaves are bipinnate with 1 – 5 pairs of pinnae beside a rachis 8 - 9 cm long. Pinnae include rachilla 5 - 10 cm long, have 3 - 11 pairs of non-symmetrical, oblong (to elliptic oblong) leaflets 1.5 - 6.5 cm long and 0.5 - 3.5 cm wide. The leaflets are nyctinastic when young, but fixed in older leaves. Arrangement of flowers is terminal or axillary (often 2 or more per axil), 5 - 9 cm diameter semi globular cluster of 15 - 40 flowers; peduncles 5 - 10 cm long. Flowers are aromatic, with pedicels 1.5 – 7 mm long; calyx puberulous, 3.5 - 5 mm long; corolla 5 - 11 mm long, ending in 5 triangular lobes covered with soft downy hairs at the apex; filaments numerous, 1.5 - 3 cm long, fused at the base, mostly white to cream, tipped with pale green, and becoming dark yellow with age. Pods are light yellowish-brown when mature, flat, glabrous, leather-like, indehiscent, 12 - 35 cm long, and 3 - 6 cm wide, rolling along the sutures, containing 3 - 12 seeds. Seeds are brown, planate ellipsoidal, 7 - 11 mm x 6 - 9 mm x 1 - 1.5 mm; 5,000 - 16,000 per kg [2] [35].

Traditional medicinal use

Albizia lebbek has a long history of use in traditional medicine, mainly for treat asthma and allergic disorders. The bark has been used in *Ayurveda* for treat bronchitis, asthma, leprosy, eczema, pruritus, worm infestation and paralysis. The tree is used as an astringent, psychoactive, antiinflammatory agent, to treat the eye, boils, cough, flu, gingivitis, lung problems, pectoral problems and abdominal tumours. In ancient Hindu art of medicine and of extending life, it is considered as an antidote against all poisons. Although it has been established that no part of the plant has any antidotal value against either snake or scorpion venoms, the bark decoction of *A. lebbeck* has shown antianaphylactic, antiasthmatic activity. These activities can possibly be assumed as supportive measures in poisoning treatment [3][4][5][8][10].

Phytochemistry

According to Mishra (2010), Ueda (2003), Pal (1995) and Miranda (2009) the whole plant contains saponin, macrocyclic alkaloids, phenolic glycosides, coumarins and flavonols [10][14][15][36], while some parts of the plant has specific components:

Bark: Three main saponins (named albiziasaponins A, B, and C) [31][36].

Leaf: Pipecolic acid derivatives and Two tri-*O*-glycoside flavonols (kaempferol and quercetin) [11], Albiziahexoside (a new hexaglycosylated saponin) [26][36].

Flower: different sterols (Taxerol, cycloartemol, lupeol, campesterol, sitosterol) [10].

Root: Echinocystic acid (saponin) [10].

Pod: 3',5 dihydroxy-4',7 dimethoxy flavone and N-benzoyl L Phenyl alaninol [12].

Bean: albigenic acid (a triterpenoid sapogenin) [13], Phenolic glycosides [16] and Flavonols [17].

De Paula (2001) studied the constitution and structure of *A. lebbeck* gum, and reported to find galactose, arabinose and uronic acid [34].

Table 1: Chemical analysis of seed [17]

Component Value	(% composition)
Moisture	4.55+0.04
Crude protein	38.04+0.40
Crude lipid	5.66+0.12
Crude fibre	11.63+0.21
Ash content	7.84+0.06
Nitrogen free extracts	32.2+0.03

Table 2: Analytical specification of dry stem bark [10]

PHYSIO-CHEMICAL ANALYSIS

Loss on drying (%w/w)	<7.0
Ash content (%w/w)	<12.0
Acid insoluble ash (%w/w)	<2.0
Total soluble solid (%w/w)	>85.0
PH of 5%w/v solution	4.0-7.0

HEAVY METAL ANALYSIS

Lead	<10ppm
Arsenic	<2
Cadmium	<1
Mercury	<0.1

PHYTO-CHEMICAL ANALYSIS

Total polyphenols (%w/w)	>20.0
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Table 3: Phytochemical screening of *Albizia lebbek* seeds [17]

Phytochemical components	Result
Cyanogenic glycosides (mg/g)	0.11
Phytic acid (mg/g)	0.25
Oxalate (mg/g)	2.80
Saponin (%)	18
Tanin (mg/g)	0.002

Bioactivity

Antiasthmatic and antianaphylactic activity

Asthma is now accepted to be a primarily inflammatory state, inflammation basic hyperactivity. Tripathi (2010) studied the effects of the decoction of the bark and flower of *A. lebbeck* for its antiasthmatic and antianaphylactic activity. According to the study results the decoctions protected the guinea pig against histamine as well as acetylcholine induced bronchospasm. Continual treatment was also able to protect the sensitized guinea pigs against antigen challenge. The researcher showed that both the bark and flower decoction had the same effect. On the other hand, the extract had no notable effect on the rat mesenteric mast cell count. It inhibited the rate of perturbation of mast cells stimulated by antigen in sensitized albino rats. It showed no effect on the adrenal, thymus and spleen weight as well as adrenal ascorbic acid, excluding the cholesterol content which decreased considerably. Although the researcher did not observe any difference between the normally disrupted mast cells counts in the control and the bark decoction treated group, when the control sensitized animals was challenged with the antigen, 69.6±9.5% of the mast cells were disrupted (compared to the bark treated sensitized animals which 27.4±11.4 % of the mast cells were disrupted). Disrupting the mast cells with antigen was notably lower in rats which were pretreated with bark decoction ($p < 0.025$). It has been proved in guinea pig sensitized with horse serum that the bark decoction considerably protected anaphylactic shock ($p < 0.025$) but it is neither intervened through the stabilization of the mast cell nor through the adrenal gland [27]. They mentioned also that hot water extract of bark had no anti allergic activity in experiment model of cutaneous anaphylaxis and mast cell stabilization activity. Hot water extract of stem bark did not show any bronchodilatory effect [10]. According to Tripathi decoction of the bark shows a notable cromoglycate-like effect on the mast cells of albino rats, and reduced the early procedure of sensitization and synthesis of reaginic type of humoural antibodies. The studies indicated the antianaphylactic activity of the plant is not only because of cromoglycate action on the mast cells, but also caused by synthesis antibodies inhibition and of T-lymphocytes suppression activity [28].

Antiinflammatory activity

Inflammation is believed to be a primary defence mechanism that helps to protect body against stimulants like infection, toxic chemicals or allergens. Achinto Saha and others (2009) studied the effect of petroleum ether, ethyl acetate, and methanol extract of *A. lebbeck* bark obtained by cold extraction of mixture of equal proportions. The extracts were tested on rat paw edema model induced by carrageenan. They observed Inhibition of edema volume after 4 hours [9]. According to Vinegar (1969) the carrageenan induced rat paw edema is a biphasic procedure. The first phase with release of histamine or serotonin and the second phase with production of prostaglandin, bradykinin, protease and lysosome. Mishra suggested the prostaglandin synthesis and inhibition of cyclooxygenase could lead in inhibition of carrageenan induced inflammation [10]. The constriction response of abdomen caused by acetic acid is a sensitive process for peripheral analgesic agent. Another study also measured the peripheral analgesic activity of the bark extract by the acetic acid induced writhing test. The extract showed considerable fall in the number of writhes with 52.4 % of inhibition [9].

Nootropic, anticonvulsant and anxiolytic activity

The effect of a saponin containing n-butanolic fraction (BF) recovered from dried leaves of *Albizia lebbeck* was studied on anxiety and cognitive behaviour in albino mice. The studies showed that BF has anxiolytic and nootropic activity [10]. BF repressed baclofen-induced hypothermia and passivity. The possessions of BF on the behaviour influenced by serotonin (5-HT), noradrenaline and dopamine have also been investigated. The brain levels of serotonin, dopamine and gamma aminobutyric acid (GABA) were also evaluated to establish a mutual relation between the behaviour with neurotransmitter levels. According to researchers the brain concentrations of GABA and dopamine were reduced, while the concentration of 5-HT was increased. The researchers suggest that saponins act by modifying GABAergic mechanism. Noteworthy development was observed in the retention ability of the normal and amnesic mice compared to their relevant controls. [10].

The ethanolic extracts of *A. lebbeck* leaves were investigated by Kasture (2005). It demonstrated anticonvulsant activity. The bioassay guided fractionation pointed to that the methanolic fraction of chloroform soluble part of ethanolic extract of the leaves is responsible for the anticonvulsant activity. The fractions were able to protect mice from maximum electro-shock, electrical kindling and pentylenetetrazole-induced convulsions. The fractions also showed inhibition efficacy on convulsions induced by lithium–pilocarpine and electrical

kindling. On the other hand, they were unsuccessful to protect animals from strychnine-induced convulsions. Kasture says the fractions antagonized the behavioural effects of D-amphetamine and increased the pentobarbitone-induced sleep. The fractions increased brain concentration of GABA and serotonin. These fractions showed also anxiogenic and general depressant efficacy of the central nervous system [25].

Antispermato-genic effect

Gupta and others (2005) reported that oral administration of saponins isolated from *A. lebbeck* bark at the dose 50 mg/kg/b.w. per day for 60 days to male rats showed a considerable decrease in the weights of testes, epididymides, seminal vesicle and ventral prostate. It reduced producing round spermatid by 73.04%, the population of preleptotene spermatocytes and spermatogonia by 65.07% and 47.48% and secondary spermatocytes by 73.41%, respectively. Sperm motility and sperm density were also reduced notably. The administration of the saponins reduced the fertility of male rats by 100%. Gupta did not observe any changes in haemoglobin, RBC and WBC count, haematocrit and glucose in the blood and cholesterol, protein, triglyceride and phospholipid in the serum. The seminiferous tubular diameter was extremely reduced and intertubular space increased compared to controls [33]. Another study showed also the antifertility activity of the methanolic pod extract of *A. lebbeck* in male albino rats [29].

Antidiarrheal efficacy

Besra (2002) investigated the antidiarrheal activity of the seed extract applying albino rats and mice. The dried and ground seeds were used for extracting with methanol. The methanol part was dried in vacuum after filtration and kept at 0°C at the investigation process. To dissolving the dry extract the investigators used normal saline when needed. The results presented the watery methanol extract of *A. lebbeck* seeds caused a significant dose dependence delay in transit at the dose 2.5 to 5 mg/kg i.p. The antidiarrheal dose of the extract was at least 10-30 times less than the LD₅₀ dose (the lethal dose found by acute toxicity studies). The intraperitoneal LD₅₀ of the watery methanol extract was found to be 82 mg/kg. The extract at 2.5-5 mg/kg i.p. showed the same antidiarrheal activity as of the of loperamide at 1 mg/kg i.p. When the extract and loperamide administered together, the efficacy increased significantly. Naloxone at 0.5 mg/kg i.p. considerably repressed the antidiarrheal activity of both extract

and loperamide. It means the opioid system should have some role in the antidiarrheal activity of the extract [30].

(Figure 1, 2 and 3) [30]

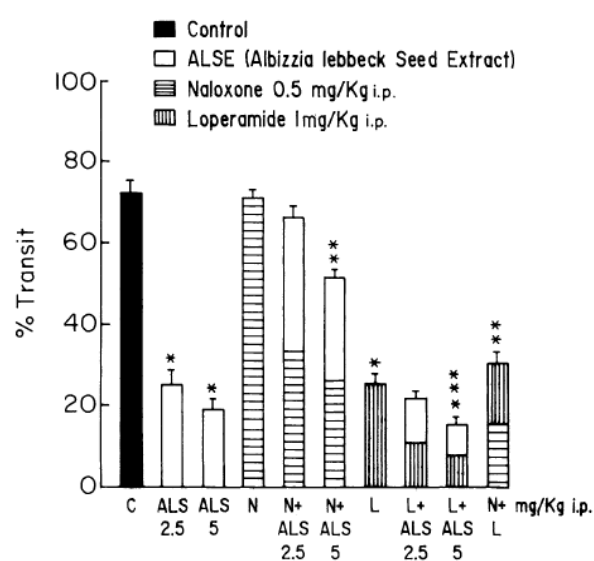


Figure 1. Histogram showing the effect of *Albizzia lebbeck* seed extract (ALS), naloxone (N), loperamide (L) and their combination on upper gastrointestinal transit in mice. *Denotes significant change from control ($p < 0.05$). **De- notes significant reduction from naloxone ($p < 0.05$) ***De- notes significant reduction from loperamide ($p < 0.05$).

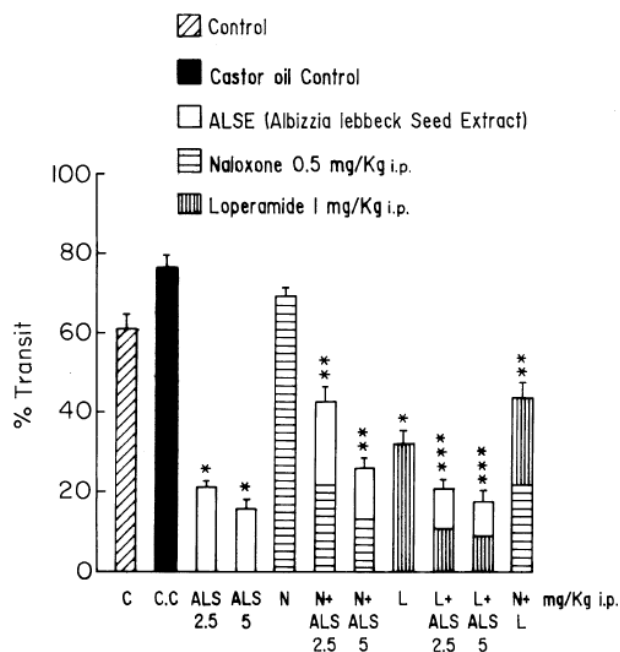


Figure 2. Histogram showing the effect of *Albizzia lebbeck* seed extract (ALSE), naloxone (N), loperamide (L) and their combination on upper gastrointestinal transit in rats treated with castor oil. *Denotes significant change from control and castor-oil control ($p < 0.05$). **Denotes significant reduction from naloxone ($p < 0.05$). ***Denotes significant reduction from loperamide ($p < 0.05$).

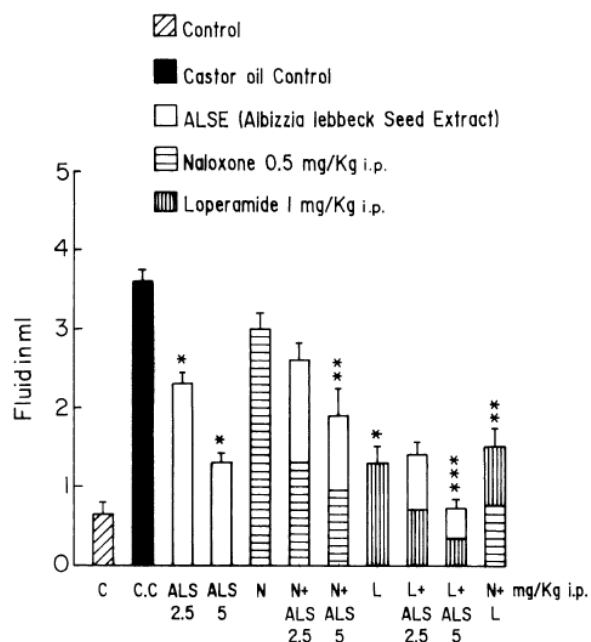


Figure 3. Histogram showing the effect of *Albizzia lebbeck* seed extract (ALSE), naloxone (N), loperamide (L) and their combination on castor oil induced intestinal fluid accumulation in rat. *Denotes significant change from castor-oil control ($p < 0.05$). **Denotes significant reduction from naloxone ($p < 0.05$). ***Denotes significant reduction from loperamide ($p < 0.05$).

According to Besra the extract acts by reducing intraluminal water value and upper gastrointestinal transit. It affects all parts of the gastrointestinal tract except possibly the colon. Prostaglandins have some considerable roles in the pathophysiological activities in the gastrointestinal tract [40]. The release of prostaglandins is also a major cause of arachidonic acid induced diarrhoea [41]. By considering these facts the researchers suggest the antidiarrheal activity of the extract may be due to inhibiting prostaglandin synthesis and release or its activities. Some studies has shown L-NAME and LNMMA (inhibitors of nitric oxide synthesis from L-arginine) prevented or reduced the diarrhoea induced by castor oil [39]. Thus nitric oxide is also a possible candidate to having a role in the antidiarrheal activity of the extract [30].

Other studies demonstrated watery, methanol and chloroform extracts of *A. lebbeck* showed activity against infectious diarrhea caused by *E. coli*, *Salmonella* species, *V. cholerae*, *A. hydrophilis* and *B. subtilis* [10].

Antibacterial activity

Mishra (2010) reports there are studies that shows the all glycosides, anthraquinone glycosides and cardenolide glycosides isolated from the stem bark have antimicrobial activity against the test cultures of *staphylococcus aureus*, *Pseudomonas aeruginosa*, *Candida albicans*, *Trichophyton rubrum*, *T. tonsurans*, *T. violaceum* and *T. mentagrophytes*. The mechanism of this effect is causing leakage of cytoplasmic constituents. The root extract has antifungal activity. The alcoholic extract of the bark shows mild anthelmintic activity against human ascaris lumbricoides *in vitro* [37]. On the other hand, Miranda (2009) studied the antibacterial activity of leaf powder which was extracted with ethanol. Test was performed against Gram-negative bacteria (*Escherichia coli* ATCC 11229, *Salmonella typhimurium* ATCC 14028 and *Salmonella choleraesuis* ATCC 10708) and Gram-positive bacteria (*Staphylococcus aureus* ATCC 29231, *Bacillus cereus* ATCC 14579, and *Micrococcus luteus* ATCC 9341). According to results the extract showed no inhibitory activity on the growth of Gram-negative and Gram-positive bacteria under experimental conditions [36]. Another investigation by Rashid (2003) showed that ethanolic extract of the pods of *A. lebbeck* contains a flavone and a nitrogenous compound, which have a mild *invitro* antibacterial activity [37].

Anthelmintic efficacy

El Garhy (2002) studied the ascaricidal efficacy of *Albizia lebbeck* by testing in vitro against the eggs and larvae of *Ascaris lumbricoides*. Water extract of 5% *A. lebbeck* was effective in killing both the infective larvae in fewer than 40 days and eggs in 20 days [19].

Galal (1991) reported the watery extract from *A. lebbeck* bark at 10-100 g/kg orally had a moderate effect against the cestode *Ascaris lumbricoides* [20].

Antihyperglycemic activity

Syiem and others studied the bark hypoglycaemic activity of *A. lebbeck*. They found that variant doses of watery methanol extract decreased blood glucose stage (in both normal and alloxan- induced diabetic mice). The efficacy of extract was dose dependent, and doses higher than 450 mg/kg were lethal to normal mice. The administration of the extract equally enhanced glucose tolerance in both normal and diabetic mice. The researchers used Metformin, Glibenclamide and Insulin as reference drugs for comparison [21].

Antiulcer activity

Peptic ulcer happens because of an imbalance between the aggressive factors such as acid, pepsin and *Helicobacter pylori*, and the defensive factors such as gastric mucus, bicarbonate secretion, prostaglandins and innate resistance of the mucosal cells. The leaves of the *Albizia lebbeck* are rich in flavons, echinocystic acid, b-sitosterol and vicenin II. The gastro-protective ability of 70% ethanolic extract of leaves in pylorus ligation, ethanol and indomethacin induced models in rat was investigated by Shirode (2008). The researchers used Albino Wistar rats (150-200g) and Swiss albino mice (18-25 g) of either sex for the study. The factors studied in pylorus ligation induced ulcer model were pH, free acidity, total acidity, gastric volume and ulcer index. Ulcer index was also settled in ethanol and indomethacin induced ulcer models. Pretreatment with test extracts reduced the ulceration in a dose dependant manner. The range of gastro protective efficacy of the test extracts reported to be 45.59% and 62.00% at 100mg/kg and 200mg/kg doses, which can be compared to that of standard lansoprazole 8mg/kg. Shirode reported the same results with the ethanol induced ulcer model also. The test extract had a dose dependent gastro protection activity (54.27% and 67.43% protection at 100 and 200 mg/kg doses). The ability of protection in the extract was

significant even compared to that of standard lansoprazole (8mg/kg). The total acidity and free acidity of the gastric secretions were measured : (104.22 ± 5.95 and 97.2 ± 6.24). According to results administration of the test extracts decreased the volume of gastric secretion, and increased the pH up to 5.15. Further, total and free acidity were also reduced considerably. However, the researchers reported that the gastric volume was not reduced with 100mg/kg dose, but considerably reduced with 200mg/kg dose. The researchers observed also that pyloric ligation caused gastric ulcerations, and administration of extracts reduced them dose dependently. So in conclusion, the researchers suggested the extract can suppress gastric damage induced by aggressive factors the gastro protective ability of it may be because of inhibition of the synthesis of prostaglandins and leukotrienes.

In addition 70% ethanolic extract of leaves of *A. lebbeck* was notably able to protect gastric mucosa against all the ulcerogenic models of the study. Shirode suggests the possible mechanism can be increasing gastric mucin content and pH, and decreasing the free and total acidity in rats, which reduces the activity of pepsin and prevent mucolysis [32].

Side effects and toxicity

Leaves have no toxins and tannins, and are low in soluble phenolic compounds. Flowers contain no adverse constituents. Pods contain saponins and intake of it may be limited, but shows no other adverse effect. There is some claim of toxicity in seed. The watery extract from bark was toxic orally to rats just at the highest dose 150 g/kg [2] [20] [25].

Conclusion

Albizia lebbeck is well known as a good source of protein as fodder. It has also a long history in traditional medicinal use in many countries. Different parts of the plant is been used as a treatment in bronchitis, asthma, eczema, worm infestation, psychoactive, anti-inflammatory agent, to treat the eye, boils, cough, flu, gingivitis, lung problems, and so on.

A. lebbeck contains saponins, macrocyclic alkaloids, phenolic glycosides, coumarins and flavonols. There are scientific studies that prove anti-inflammatory, antiasthmatic and antianaphylactic activity of the plant. Although there were few studies about the effect of the extracts on eye and ophtalmia, it is possible the antiinflammation activity could due to treatment of some kinds of ophtalmia.

The antidiarrheal activity of the plant has scientifically been investigated, and the possible mechanisms of the effect have been described before.

The antispermatogenic and antiulser efficacy of the plant have also been proved by some investigations. It seems that *Albizia lebbeck* has a valuable potential to design further clinical studies in both traditional and nontraditional activities range it has.

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Pictures references

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10 *XYLIA DOLABRIFORMIS* BENTH.



Introduction

Family	<i>Leguminosae</i>
Butanical name	<i>Xylia dolabriformis Benth.</i>
Burmese name	Pyin, Pyinkado
Parts of plant used	Seeds, bark
Claimed medicinal Properties	Oil from seeds in rheumatism, bark astringent [1].

Xylia dolabriformis is a Perennial deciduous moderate size tree with heavy, hard and durable wood, native to: India, Cambodia, Laos, Myanmar, Thailand and Vietnam. It is well-known as an important timber tree in Myanmar [2] [3] [4]. Whilst other useful parts such as bark and the oil from seeds have been used in some countries to treat rheumatism, fever, leucoderma, vomiting, edema, diarrhea, diabetes, allergic rhinitis, hiccough, obesity, itching and general weakness[1] [3].

Synonym names

According to the International legume database and information service, the accepted name of the plant is *Xylia xylocarpa* (Roxb.) Taub. [4]. Synonym names including *Acacia xylocarpa* (Roxb.) Willd. , *Inga xylocarpa* (Roxb.) DC., *Mimosa xylocarpa* Roxb., and *Xylia dolabriformis* Benth are also been used [3] [4][5] [6] [7].

Searching whole name *Xylia dolabriformis* in all records in IPNI (international plant names index) gives 1 result:

- Leguminosae *Xylia dolabriformis* Benth. -- J. Bot. (Hooker) 4: 417. 1842 (IK)

Other common names: Ironwood of Burma (En), Jambu (Hi), Pyinkado, Suria (Hi), Tangan (Hi) [4], Seesam (Hi), Seeso (Hi), Irupool (Malayam), Kusimsipa; Kapila; Krishnasara; Bhasmagrabha; Avasadini (Sanskrit) [3].

Results of searches in literature

Searching the name of ***Xylia dolabriformis*** in Google scholar resulted 169 results, meanwhile the same search plus ***medicinal*** resulted 48 results, 26 January 2011.

Search for "Any word= ***Xylia dolabriformis*** "in "Articles" in X-port found 4 result, in Pub Med found no result, and in the ISI WEB OF KNOWLEDGS resulted 4 results, 26 January 2011.

Searching the synonym name ***Acacia xylocarpa*** resulted 437 in Google scholar including one relevant result [8]. 24 January 2011

Searching the synonym name ***Xylia xylocarpa*** in SciFinder (after removing duplicates) resulted 29 results (29 January 2011), in Google scholar resulted 502 (plus ***medicinal***: 128) and one relevant result [9], in PubMed 3 results including one relevant [10] and in ISI 14 results including one relevant result [12] . 25 January 2011

Searching the synonym name ***Inga xylocarpa*** in Google scholar resulted 61 (plus medicinal 17) and in ISI resulted 1, including one relevant result [11]. 26 January 2011

Searching the synonym name ***Mimosa xylocarpa*** in scholar resulted 112 (plus medicinal 42) all irrelevant, 26 January 2011. It may illustrate the popularity of the plant in researches.

Family of *Leguminosae*

Legumes, the third largest flowering plant family, are an important ingredient of nearly all terrestrial biomes, on all continents (except *Antarctica*). The legume (or bean) family, which includes lentils, peas, beans, peanuts and soya, is important as a source of food because of its high protein content. These species range from dwarf herbs of arctic and alpine vegetation to massive trees of tropical forest. Many legumes are capable to fix atmospheric nitrogen in association with root bacteria or species of fungi. This tactics allows them to colonizing and growing in even the poorest soils, even as also helping to develop them. The main feature of the family is the fruit, a peapod which officially is known as a Legume. The Legume is adapted in many ways to make possible spreading by wind, animals and water. The family is divided into three subfamilies: *Papilionoideae*, *Caesalpinioideae* and *Mimosoideae*.

Sometimes these subfamilies are documented as three separate families. The three subfamilies are usually recognizable by their flowers. The *Mimosoideae* are mostly tropical or subtropical trees and shrubs characterized by their small, regular actinomorphic flowers which are. The

stamens are maybe the most beautiful part of the flower, the five not immediately obvious petals. The leaves have double pinnate leaflets [13].

Morphologic description

Xylia dolabriformis is a non- climbing moderate size tree that grows up to 30 meters in height. Leaves compound, par pinnate, leaflets ovate-oblong, acute or acuminate, and shiny. Flowers are yellowish axillary or terminal heads. Fruits are large woody curved pods; contain 6-10 dark oblong seeds [3]. It grows on hilly and undulating countries, but also on flat ground and thrives on the lower slopes of hills and in well drained valleys. The tree is a shade bearer, particularly in youth. It is sensitive to drought when young [2].

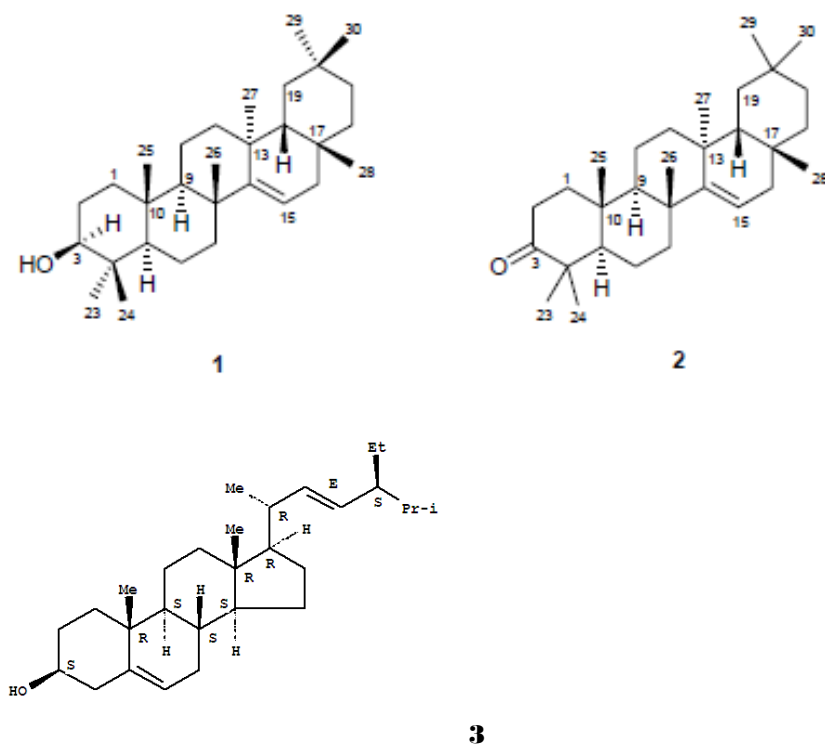
Traditional medicinal use

X. dolabriformis is used to treat rheumatism, fever, leucoderma, vomiting, edema, diarrhea, diabetes, allergic rhinitis, hiccough, obesity, itchiness and general weakness [1] [3].

Phytochemistry and chemical structures

Siddhuraju (1995) studied the chemical evaluation of raw seeds of *X. dolabriformis*. Results showed the mature seeds contain 29.5% crude protein (The major components were globulins and albumins), 14.78% crude fat, 8.02% crude fiber, 5.11% ash and 42.6% crude carbohydrates [20]. The fat contained mainly oleic, linolic, behenic and lignoceric acids, traces of palmitic, stearic and cerotic acids (and a phytosterol) [21]. Laidlaw (1963) was one of the first researchers who described and characterized isolating the heartwood constituents diterpens: manoyl oxide, 3-oxomanoyl oxide, sandaracopimaradien-3-one, -3 β -ol, and -3 β ,18-diol from the plant [18]. Akshaya Kumar (1976) had already isolated a trimeric proanthocyanidin from the stem bark which indicated as dolabriproanthocyanidin [17]. Mester (1979) in another study reported trans-5-hydroxypipelic acid in the leaves of the plant [10]. Previous researches resulted also in isolating tannins, oil and triterpene [15]. In a phytochemical study by Tareg (2009) three compounds were isolated from the petroleum ether extract of the dried leaves of *X. dolabriformis*. The structures were determined to be taraxerol (1), taraxerone (2) and stigmasterol (3) (Figure 1) [14].

Figure 1: Taraxerol, taraxerone and stigmasterol



Bioactivity

Antileishmanial agent

Although in some studies (mostly in China) on medicinal efficacy of multiple mixtures including *X. dolabriformis* extract has been reported to show several considerable effects, it is difficult to conclude which part of the mixture was the main effective ingredient. So far it is not reported some trustable scientific or clinical studies on bioactivity of the plant.

Clinical studies

No clinical study has been found about *X. dolabriformis* so far.

Side effects and toxicity

No scientific study has been found on side effects or toxicity of *X. dolabriformis* so far.

Conclusion

Some diterpens are known to have antiinflammatory effect. Tannins are also known as an astringent. Since these compounds are found in the extracts of *X. dolabriformis*, it may describe the traditional use of it as astringent and treatment of rheumatism in Burma. There are studies about traditional products such as AZMOLTM (which *X. dolabriformis* is a herbal constituent of) showing effect to treat asthma and dyspnea, neoplastic, and furthermore anti-oxidative and antiinflammatory effects [19]. In such mixtures it is difficult to find the main responsible component which has the named effect, thus it seems to be needed more specific researches to find out the effective part or plant in these kinds of mixtures.

Due to there have not been found some chemical, biological or toxicological studies that can describe biological and toxic features of the plant, it is needed further scientific researches to decide about the medicinal capacities of the plant.

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Pictures references

Flowers of India, photograph: Shekar Marathe (Read 27 January 2011)

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Conclusion

In this exercise it was undertaken a fairly extensive literature search of 10 selected medicinal plants from Burma in various scientific databases. Results of literature search were varied. For some of the plants it was many interesting scientific investigations but for some it was found no studies at all. Below is a brief conclusion for each plant that has been studied in this thesis.

***Ficus religiosa* L.**

In Myanmar, leaves are used to treat asthma. In other countries, it uses as cooling, astringent, in inflammations and glandular swellings of neck, stomatitis, cleaning ulcers, aphrodisiac, treating lumbago, constipation, to prevent gum disease, as laxative, alexipharmic, to promote digestion, treating foul taste, thirst and heart disease. The powdered fruit is taken to cure asthma, refrigerant and urinary problems treatment. Barks are used with some honey to treat gonorrhoea, ulcers, skin diseases, scabies and healing wounds. Different parts of the plant are also used as antibacterial, antiprotozoal, antiviral, astringent, to treat diarrhea and dysentery.

Biological studies have proved that the bark extracts have (*in vitro*) antibacterial, antioxidant, and (*in vivo*) antidiabetic, hypolipidemic and antihelminthic activity. The fruit extract showed (*in vitro*) antitumor and (*in vivo*) anti-amnesic and anticonvulsant activity. Leaves extract showed antimicrobial effect *in vitro*. Stem bark extract showed anti-inflammatory and analgesic activity *in vivo*. Phytosterolin, serotonin and quercetin are found in *F. religiosa*. Phytosterolin has CNS stimulant effects. Serotonin has an important role in control of mood, appetite, sleep, as well as muscle contraction. It also has some cognitive roles, including in memory and learning. Quercetin has antigonadotropic, anti-inflammatory, antibacterial, antiviral and antihepatotoxic effects.

Most of the traditional medicinal uses of *Ficus religiosa* are confirmed. Exceptions are the antiasthmatic, aphrodisiac, alexipharmic effects. Unsuccessful results about the antiasthmatic effect of the plant may be because of the high amount of serotonin in methanol extracts which has shown contractile response in guinea pig airways. More specific studies are needed to decide about antiasthmatic efficacy of the plant.

***Mimosa pudica* L.**

Whole plant uses as diuretic and antiseptic agent in Myanmar. In other parts of the world it uses to treat stomach pain, as a sedative, to stop menstruation and for gonorrhea, as a

temporary birth control, to treat the snake bite patients, haemorrhoids, to stop urination during sleep, topically to draw out the purulent stuff from boils and ulcers, orally to break apart kidney stones, curing dysentery, frequent urination, burning sensations in the vaginal area, leucorrhoea, bleeding of penis, diarrhea, hypertension, skin wounds, toothache, to treat headache, stomachache, alopecia, diarrhea, dysentery, insomnia, as an antidote to poison and sedative.

Scientifically proved bioactivities of *Mimosa pudica* are antifertility, antidepressant, anticonvulsant, antinociceptive, antibacterial, antivenom against *Naja kaouthia* (cobra) and antioxidant activity so far. The plant is also considered as a non-toxic plant. The most of traditional uses of the plant seems to have scientific basis. Several scientific studies confirm that the plant has potential antibacterial and antifertility components. It is needed some more *in vivo* and clinical studies as well.

***Tinospora cordifolia* Miers.**

Leaves and stem of the plant uses in Myanmar as stomachic and cholagogue. Other countries have some other traditional uses for the plant such as treating urinary diseases, dyspepsia, fever, general debility, hepatic fibrosis, peritonitis, cancer, sepsis, improving immune system and the body's resistance against infections, and as an immunomodulator in immunosuppression of obstructive jaundice. It is used both internally and externally in treatment of over 50 common diseases. The juice is also applied inside the eyes for the treatment of conjunctivitis and cataract.

Proapoptotic, immunostimulating, hypolipidaemic, anticancer, antiallergic, antiosteoporotic, radio sensitizing (in carcinoma) and radio protective activity of the plant have scientifically proved. It was also found that the plant has antioxidant effect. This should arouse the motivation to examine the plant more closely; since the antioxidant effect has been mentioned to be able to help in cancer treatment (reduces damage from free radicals in the body). Some indications from the traditional use in other countries such as immunomodulator and anticancer confirmed. Antiallergic and immunostimulating effects of the plant may also support traditional uses against some common symptoms such as treating urinary problems, skin diseases, respiratory troubles (particularly in asthma) and fever.

***Antiaris toxicaria* Lesch.**

In Myanmar the latex of the plant uses as a heart tonic and febrifuge. The bark latex is one of the principle parts of dart and arrow poisons. In other countries it is also applied to cuts,

wounds and skin diseases such as eczema and leprosy. It is taken internally as a cathartic. Seeds, leaves and bark are used as a febrifuge and the seeds also as an antidyenteric. The bark is used as a soothing and vermifuge, and to treat hepatitis. The leaves and root are used to treat mental illnesses.

Anticancer, antioxidant activity, treatment of osteoporosis and dose- dependent effects on blood pressure and electrocardiogram has proved scientifically. Traditional use of the plant as heart tonic has scientific basis so far. The plant is relatively little studied, so it might have been interesting to investigate it more.

***Entada phaseoloides* Merr.**

Seeds uses as fish poison, febrifuge, emetic, hair growth stimulant, contraception, aphrodisiacs, to treat rheumatic lumbar and leg pains, sprains, bruises, jaundice, edema, cerebral haemorrhage, snake bites, glandular swellings in the axilla, loins and joints, and swollen hands and feet.

Antiinflammatory, molluscicidal, and photocytotoxic activity of the plant have scientifically confirmed so far. It means that of all the effects that the plant may have from traditional use, rheumatic treating and anti edema effects have scientific basis until now. The plant may be a research candidate for antiinflammatory products. The seeds are toxic because of having high level of saponins. This describes use of the plant as fish poison.

***Acacia pennata* Willd.**

Bark of the plant uses in asthma and bronchitis in Myanmar. In other parts of the world it uses to treat scalding of urine, bleeding gums, digestive complaints, cholera disease, relief of headache, body pain, snake bites, stomach pain, as a haemostatic and even to cure fish poisoning.

Through scientific studies, the antiinflammatory, antinociceptive, tumour suppressing, antifungal and antioxidant activity of *Acacia pennata* have been confirmed so far. Using the plant as a fish poison is due to the tannins plant have (which influences the respiratory organs of fish). There have been few scientific studies of the plant. Traditional use against asthma is confirmed through the studies which have proved the antiinflammatory effect of the plant. *Acacia pennata* can also be a potential source to produce a new antifungal medicine.

***Pithecellobium dulce* Benth.**

Leaves uses as abortive and digestive in Myamnar. In other countries leaves uses as a plaster to allay pain, to relieve convulsions, anti diabetic, cure to indigestion and induce abortion. Other traditional uses of the plant are febrifuge, treating dysentery, earache, leprosy, peptic ulcer and toothache, emollient, soothing and larvicide.

There are scientific studies which prove isoflavonoid isolated from root extract have abortion inducing activity. Also anti inflammatory, antivenom (against *Naja kaouthia*), antidiabetic (mild effect), hepatoprotective, antiulcer, antibacterial, antifungal and protease inhibition activity of the plant are proved through researches. Thus most of the traditional uses of the plant are confirmed.

***Pithecellobium lobatum* Benth.**

Seeds uses in diabetes in Myanmar. In other countries leaves and barks are crushed and applied in chest pains, pains and skin problems. Ashes acquired by burning the old leaves are applied on itch, and ashes acquired by burning the young leaves are applied on cuts, wounds. Fruits are eaten to treat diabetes and hypertension.

Since no scientific study is been found about bioactivity so far, it is not possible to confirm any of traditional uses of the plant.

***Albizia lebbek* Benth.**

Traditional medicinal use of the plant in Myanmar believes that leaves can treat ophtalmia and bark is helpful in dysentery. *Albizia lebbek* has a long history of use in traditional medicine in other countries, mainly for treat asthma and allergic disorders. It is also used to treat leprosy, eczema, pruritus, worm infestation, paralysis, as astringent, psychoactive, antiinflammatory agent, to treat the eye, boils, cough, flu, gingivitis, pectoral problems and abdominal tumours. In India the plant is believed to be an antidote against all poisons, although it has been established that no part of the plant has any antidotal value.

The antidiarrheal effect of *Albizia lebbek* is proved through a study on extracts of the plant against infectious diarrhea caused by *E. coli*, *Salmonella* species, *V. cholerae*, *A. hydrophilis* and *B. subtilis*. Other scientific studies have proved that the plant has also antiasthmatic, antianaphylactic, antiinflammatory, nootropic, anticonvulsant, anxiolytic, antispermatogenic, anthelmintic, antihyperglycemic, antibacterial and antiulcer activities. Although there were few studies about the effect of the extracts on eye and ophtalmia, the antiinflammation effect of the plant may be helpful to treating some kinds of ophtalmia. It seems that *Albizia lebbek* has a valuable potential to be chosen for further clinical studies.

***Xylia dolabriformis* Benth.**

In Myanmar oil from seeds uses in rheumatism, and bark as anastringent. In other countries it is used to treat fever, leucoderma, vomiting, edema, diarrhea, diabetes, allergic rhinitis, hiccough, obesity, itchiness and general weakness.

Although in some studies (mostly in China) on medicinal efficacy of multiple mixtures including *X. dolabriformis* extract has been reported to show several considerable effects, it is difficult to conclude which part of the mixture was the main effective ingredient. Some diterpens are known to have antiinflammatory effect. Tannins are also known as an astringent. Since these compounds are found in the extracts of *X. dolabriformis*, it may describe the traditional use of it as astringent and treatment of rheumatism in Burma. Due to there have not been found some chemical, biological or toxicological studies that can describe biological and toxic features of the plant, it is needed further scientific researches to decide about the medicinal capacities of the plant.